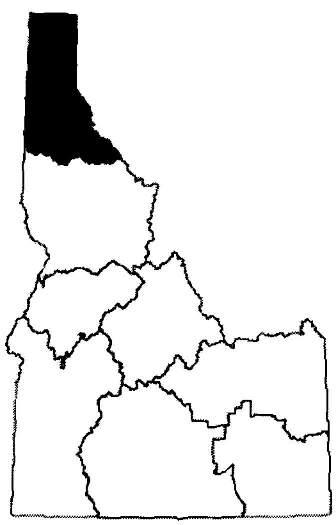
FISHERY MANAGEMENT INVESTIGATIONS

IDAHO DEPARTMENT OF FISH AND GAME

FISHERY MANAGEMENT ANNUAL REPORT

Cal Groen, Director



PANHANDLE REGION

2008

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2008 PANHANDLE FISHERY MANAGEMENT REPORT

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2008 Panhandle Region Fishery Management Report

PRIEST LAKE INVESTIGATIONS

ABSTRACT

Panhandle Region staff surveyed the lake trout *Salvelinus namaycush* population in Priest Lake during 2008 to note any indications that lake trout were being overexploited and examine the decline in the mean size of harvested fish. Twenty-six lake trout were aged by examination of sectioned otoliths. We estimated lake trout in the 400 mm to 600 mm size range to be 7 to 13 years old and have a slower growth rate than those in Lake Pend Oreille. The slow growth may explain the smaller size at maturity and the preponderance of smaller fish in the harvest. We also tagged 61 lake trout with $50 reward spaghetti tags during April 2008. During the first 9 months of this study, only one tag was returned for a preliminary exploitation rate of 2%. Over harvest did not appear to be a problem in the lake based on this estimate of exploitation, as well as exploitation in previous studies. High harvest also does not appear to account for the reduced size in the creel due to the cropping of older fish.

We counted a total of 1,480 kokanee *Oncorhynchus nerka* spawners at five historic locations along the shoreline of Priest Lake in November. The numbers of kokanee spawners observed at the five sites on Priest Lake were as follows; Copper Bay 223, Huckleberry Bay 0, Cavanaugh Bay 346, Hunt Creek beach 884, and Indian Creek Bay 27. The spawner count indicated a continuing decline in kokanee abundance since the peak count of 6,117 kokanee during 2004.

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INTRODUCTION

Like nearly all large lakes, Priest Lake had pronounced changes in its fish species composition and sport fisheries over the last half century. Prior to fish introductions, Priest Lake's major fishery was for cutthroat trout *O. clarkii* with some harvest of bull trout *S. confluentus*. Between 1955 and 1978, cutthroat trout catch fluctuated around 2,500 fish annually, but declined by the early 1980's (Mauser and Ellis 1985). Kokanee were introduced into Priest Lake in the early 1940's and became the most abundant game fish. Harvest of kokanee in 1956 was estimated at 100,000 fish (Bjornn 1957). This fishery collapsed in the late 1970's and remains closed to this day (Mauser and Ellis 1985). Lake trout were introduced in Priest Lake in 1925. By the 1980's the fishery was dominated by lake trout harvest. The most recent creel survey in 2003 estimated a lake trout catch of 48,322 fish during the 10-month census period. Anglers targeting lake trout accounted for 99% of the total effort (Liter and Horner in press).

Our work in 2008 was to continue to monitor the dynamic fish populations in the lake. Counts of spawning kokanee in Priest Lake were used to determine if kokanee were continuing to decrease in abundance. We examined the exploitation and growth rates of lake trout to determine if they were being over-exploited and understand why the size of lake trout in the harvest was declining.

STUDY AREA

Priest Lake is a glacial lake located in the northwest corner of the Idaho Panhandle about 30 km south of the Canadian border. The lake is in the Selkirk Mountain range amid a coniferous forest watershed of 1600 km^2. Priest Lake has about 100 km of shoreline, a surface area of 9,454 ha, a mean depth of 38 m, and a maximum depth of 112 m. The lake is known for its low productivity and clear water.

Native fish species present in the lake include westslope cutthroat trout, bull trout, mountain whitefish *Prosopium williamsoni,* pygmy whitefish *P. coulteri*, redside shiner *Richardsonius balteatus*, peamouth chub *Mylocheilus caurinus,* largescale sucker *Catostomus macrocheilus*, and northern pikeminnow *Ptychocheilus oregonensis*. Introduced species include lake trout, kokanee, brook trout *S. fontinalis*, yellow perch *Perca flavescens*, largemouth bass *Micropterus salmoides*, smallmouth bass *M. dolomieui,* northern pike *Esox lucius*, green sunfish *Lepomis cyanellus* and tench *Tinca tinca*.

OBJECTIVES

1. Manage Priest Lake to provide both a yield and a trophy fishery for lake trout.
2. Provide a limited consumptive harvest of kokanee in Priest Lake.

METHODS

Lake Trout Growth

We collected otoliths from 26 lake trout that were harvested by anglers fishing Priest Lake to determine their age. Fish were caught in two areas known for having high concentrations of smaller lake trout. The one exception to this was the largest fish (830 mm) that was caught away from the aggregations of smaller fish. Lake trout ranged in size from 403 mm to 830 mm in total length, and were collected in April and May, 2008. Otoliths were removed, potted in epoxy resin, and thin sectioned with an Isomet 500 saw. Top surface was polished using 1.0 micron Alpha alumina C micropolish. Annuli were counted under a light microscope at 40 to 100 power. We added an extra year to the annuli count to account for lake trout not having formed annuli for the current year. Mean total lengths for each age class of lake trout were inputted into the Fishery Analyses and Simulation Tools (FAST) model, Version 2, to calculate the Von Bertalanffy growth equation (Von Bertalanffy 1938).

Lake Trout Exploitation

We tagged lake trout in Priest Lake to determine their exploitation rate. Sixty-one lake trout were caught by hook-and-line on April 11, 16, and 17 and tagged with Floy spaghetti tags. Tags were labeled with the text: “Reward $50 IDFG expires 6/1/09” and a tag number between 08-0001 and 08-0068. Twenty-seven of the lake trout were tagged and released at popular fishing spots near Bartoo Island and Eight Mile Island. Thirty-four lake trout were tagged at lesser known locations at the northern and central parts of the lake. Lake trout that bloated while landing the fish were lowered back to their original depth using an inverted metal plant hanger on a rope. Fish with questionable wounds or very pronounced bloating were not tagged. Lake trout ranged in length from 357 mm to 581 mm with a mean length of 453 mm.

Kokanee Spawner Counts in Priest Lake

Shoreline areas of Priest Lake were surveyed to quantify the number of kokanee spawners. Counts were conducted at five historic spawning areas on November 3, 2008. We conducted the surveys using a boat with two observers standing on the bow while a third person drove the boat contouring the shoreline at a depth of about 3 m. Each observer counted spawners and an average of the two counts was used as the estimate for each of the five sites. Our efforts were concentrated on the area between the Granite Creek delta and Copper Bay, Indian Creek campground and marina, Cavanaugh Bay Marina, Hunt Creek delta and Huckleberry Bay (Figure 1).

Twelve dead kokanee were collected and measured (total length) during the spawner survey. Total length was estimated if the end of the caudal fin was missing.

RESULTS

Lake Trout Growth

Ages of lake trout ranged from 6 to 19 years based on otolith analysis (Figure 2). Excluding the largest fish, we calculated a Von Bertalanffy growth equation as $L_t = 515.993(1-e^{-0.504(t-0.573)})$. Based on this equation the maximum theoretical length that lake trout could obtain was 516 mm. Lake trout in the 400 mm to 600 mm size range were estimated to be 7 to 13 years old and have a slower growth rate than those in Lake Pend Oreille (Figure 2).

Lake Trout Exploitation

As of January 6, 2009, only one spaghetti tag was returned from a lake trout. A preliminary exploitation rate would be 2% if based on this one tag return. This study will continue through April 2009 so that exploitation can be measured over one full year.

Kokanee Spawner Counts in Priest Lake

A total of 1,480 kokanee spawners were counted at five shoreline sites in Priest Lake. Number of kokanee spawners observed at each site was: Copper Bay- 223, Huckleberry Bay- 0, Cavanaugh Bay- 346, Hunt Creek beach- 884, and Indian Creek beach- 27 (Table 1).

Twelve dead kokanee were collected from the spawning areas and measured. Mean length of male and female kokanee spawners was 373 mm and 338 mm, respectively. They ranged in size from 328 mm to 400 mm. Total length of kokanee in Priest Lake has remained exceptionally large for northern Idaho for the last eight years (Figure 3).

DISCUSSION

Lake Trout Growth and Exploitation

Our preliminary exploitation rate of 2% (based on the first 9 months) was very low but not inconsistent with past estimates. Fredericks and Horner (2003) estimated a similar return rate for fish tagged between 1983 and 1999. For the first full year after tagging, return rates ranged from 0 to 16.8% with a weighted mean of 6.8% (corrected for non-reporting of tags). This range of exploitation rates appears to be quite low. Healey (1978) suggested that total mortality rates of 50% were the maximum lake trout populations could sustain while remaining viable. Adding our exploitation estimate to a natural mortality rate of 25% (Fredericks and Horner in press) yielded total mortality rate well below the 50% total mortality level.

There was, however, some reason to remain concerned. In Priest Lake, lake trout harvest was estimated at 1.6 kg/ha in 1986 (Mauser et al. 1988) and 3.0 kg/ha in 2003 (Liter and Horner in press). Healey (1978) predicted that lakes with yields over 0.5 kg/ha were being over fished. The lake trout management plan for the state of Maine also recommended limiting harvest to less than 0.5 kg/ha (Johnson 2001). We cannot at this time reconcile how Priest Lake could have such high yields of lake trout but have such low exploitation rates. We therefore recommend continued monitoring of the lake trout population through periodic creel surveys and tagging studies. We also recommend examining the delayed mortality of caught and tagged lake trout to determine if it is influencing our estimates of exploitation.

Size of lake trout in the angler's creel has been declining since the 1950's and fewer numbers of the larger lake trout were seen in the latest creel survey in 2003 (Liter and Horner in press). We considered two possible explanations for the decline in size. First, anglers could be cropping-off larger fish in the population. We would then expect to see high exploitation, but good growth rates of smaller lake trout. The second possibility was that lake trout were growing slower and fewer fish were reaching the larger sizes. If this were true we should be able to note slow growth rates regardless of exploitation. Based on work this year, exploitation appeared low with rather slow growth rates. This gave the appearance of having too many lake trout competing for rather limited food resources. With declines in kokanee and cutthroat, lake trout <500 mm have a diet of mostly opossum shrimp *Mysis relicta.* This could be reducing the growth rates of fish once they reach 500 mm. The problem of declining sizes, therefore, does not appear to be related to anglers. We recommend continuing the harvest regulation of six lake trout of any size with future monitoring of exploitation and yield.

One limitation of this study was that most lake trout used for aging came from three areas known to have concentrations of smaller lake trout (generally under 600 mm). It is possible that lake trout in these areas feed heavily on shrimp, but as they get older, move to other areas of the lake, change to a diet of fish, and then resume faster growth. The single larger fish in this study was 19 years of age and 830 mm. This fish had a growth rate similar to fish from Lake Pend Oreille (Figure 2). We recommend that future age-and-growth studies include fish of all sizes and from various parts of the lake.

Two management objectives from the 2007 – 2012 Fisheries Management Plan were addressed in this investigation (IDFG 2007). The first was to manage the lake for both a trophy and a yield fishery for lake trout. Estimates of yield and catch-per-unit-effort (CPUE) in past creel surveys indicated that the yield fishery is doing well (Liter and Horner in press). The trophy component, however, appeared to have declined. The estimate of growth rates seen in this study would indicate a potential lack of forage as the reason for the decline in the numbers of larger lake trout. This was also consistent with the low numbers of kokanee seen in the spawner counts.

The second objective was to consider opening a limited fishery for kokanee. Kokanee appeared to be declining based on our spawner count in 2008 (Table 1). The large size of kokanee collected during the spawning season was also indicative of their low densities in the lake (Figure 3). A hydroacoustic survey conducted in 2004 estimated only 22 kokanee fry/ha and 7 pre-spawning age kokanee (ages 1 to 4)/ha (agency files). Therefore the kokanee population appeared too low to sustain a fishery at this time.

MANAGEMENT RECOMMENDATIONS

1. Continue to monitor kokanee spawners on Priest Lake and expand surveys to include lower sections of historic spawning tributaries.

2. Depending on priorities, conduct a creel survey on Priest Lake at about 5-year intervals to estimate harvest and yield of lake trout and determine if it is being over-fished.

3. Examine the delayed mortality of caught and tagged lake trout to determine if it is influencing our estimates of exploitation.

4. Conduct a hydroacoustic survey on Priest Lake during mid-summer to estimate kokanee and lake trout densities and compare to previous estimates.

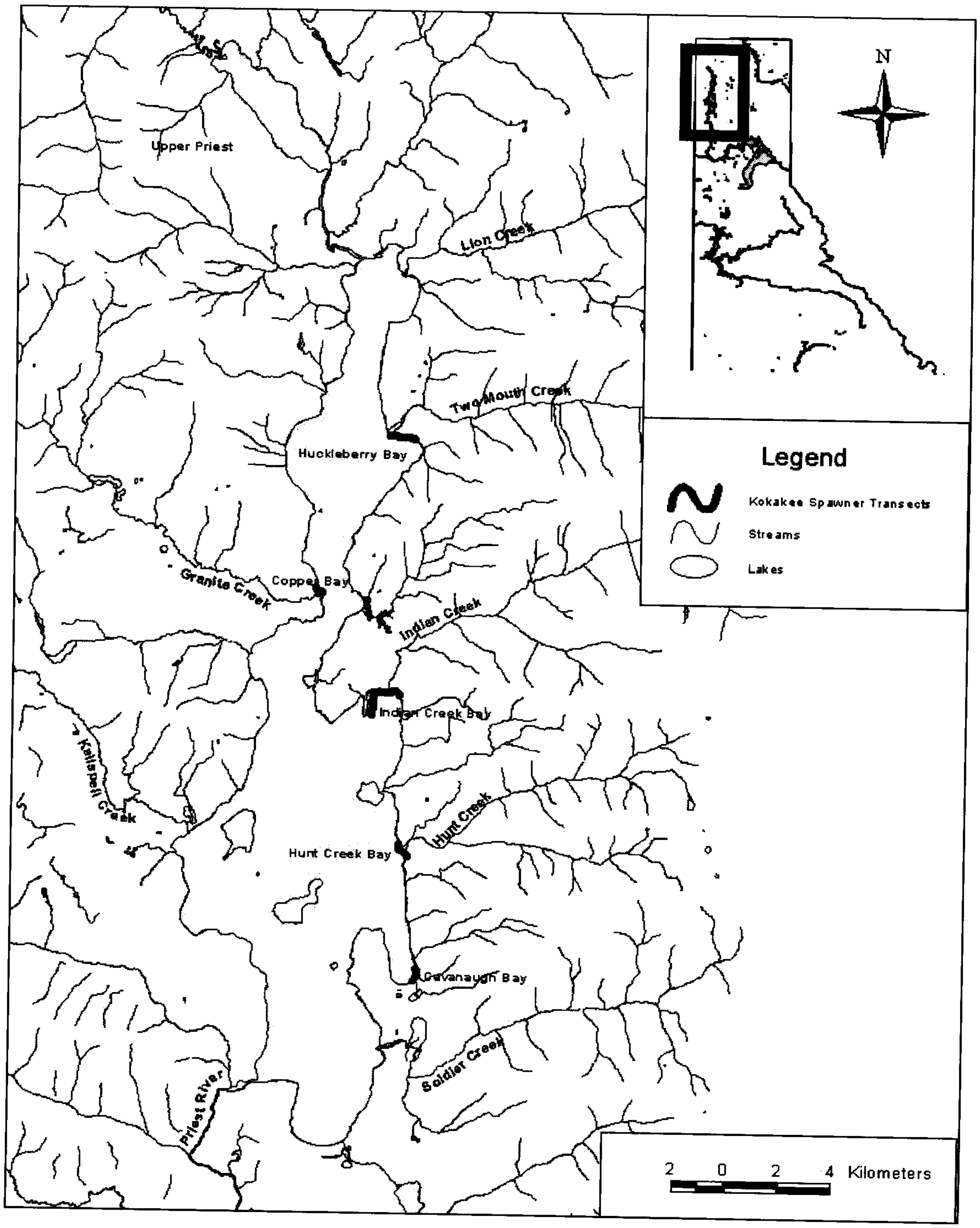

Figure 1. Location of kokanee spawner counts on Priest Lake, Idaho, 2008.

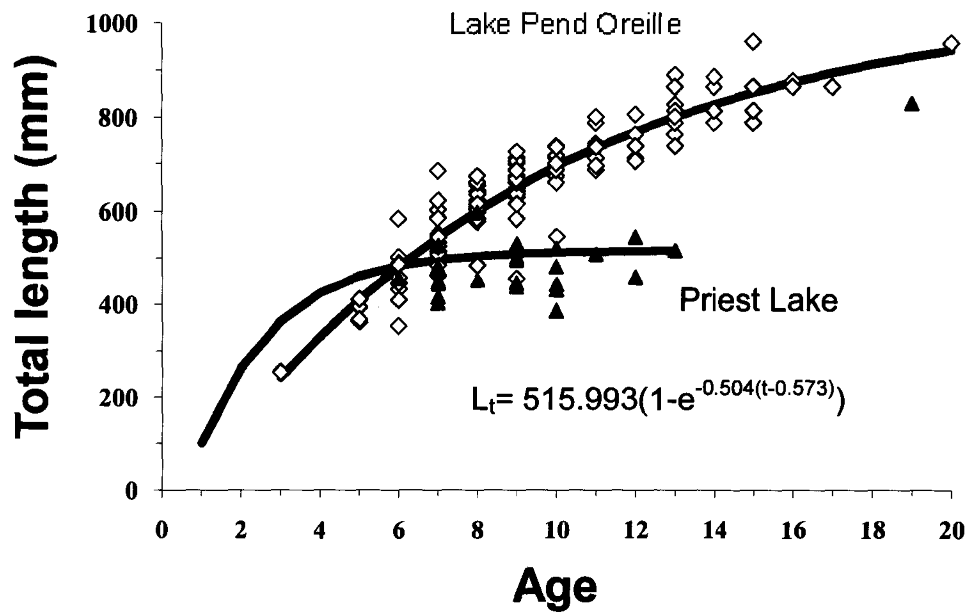

Figure 2. Growth of lake trout in Priest Lake and Lake Pend Oreille. The 19 year old lake trout was not included in the Von Bertalanffy growth curve for Priest Lake.

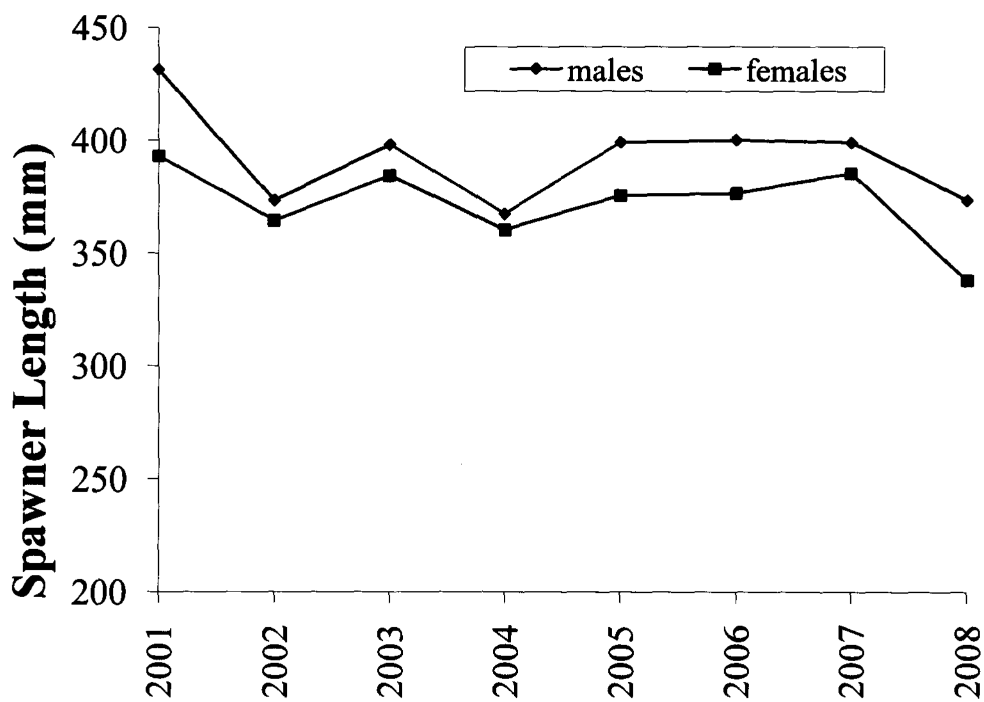

Figure 3. Mean total length of male and female kokanee spawners in Priest Lake, Idaho, from 2001 to 2008.

Table 1. Counts of shoreline spawning kokanee in Priest Lake and Upper Priest Lake, Idaho, 2001- 2008.

Location	2001	2002	2003	2004	2005	2006	2007	2008
Priest Lake								
Copper Bay	588	549	1237	1584	906	1288	308	223
Cavanaugh Bay	523	921	933	1673	916	972	463	346
Huckleberry Bay	200	49	38	359	120	43	38	0
Indian Crk Bay	222	0	0	441	58	0	40	27
Hunt Crk Mouth	232	306	624	2060	2961	842	1296	884
Upper Priest Lake								
West shoreline	10	---[1]	---[1]	---[1]	---[1]	---[1]	---[1]	---[1]
Total	**1775**	**1825**	**2832**	**6117**	**4961**	**3145**	**2145**	**1480**

[1]. Upper Priest Lake was not included in the spawner counts due to low water in the Thorofare and no access to Upper Priest Lake.

2008 Panhandle Region Fishery Management Report

UPPER PRIEST LAKE BULL TROUT ENHANCEMENT

ABSTRACT

Harbor Fisheries, Inc. of Baileys Harbor, Wisconsin was contracted to gill net and remove lake trout from Upper Priest Lake in 2008 using their 47 foot commercial gill net boat with funding from the U.S. Fish and Wildlife Service (USFWS). Gill nets were fished from June 3 through June 12, 2008. Catch rates of lake trout varied among locations and days in Upper Priest Lake. Catch rates were generally higher along shorelines and lower in deeper mid-lake sets. Catch rates were generally higher at the start of the effort, and tapered off over the 10-day period. We fished a total of 55.7 km of gill net (34.6 mi) averaging 5,974 m net/day. A total of 2,207 lake trout were caught and removed. Processed lake trout were filleted and given to various food banks throughout the Idaho Panhandle for distribution to the indigent.

Abundance of lake trout was estimated using a Leslie Depletion Model (Ricker 1975). We estimated lake trout population abundance at 2,307 fish. Adult lake trout abundance was also estimated at 5,359 using a Peterson mark-recapture estimate. Density of the lake trout in Upper Priest Lake (4.1 - 9.5 adults/ha) was average as compared with other North American populations.

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INTRODUCTION

It has been well documented that introduced lake trout have the tendency to suppress other native and non-native species through predation and/or competition (Donald and Alger 1993, Fredenberg 2002, Hansen et al. In Press). Historically native bull trout provided a trophy fishery in Upper Priest Lake with an annual catch of 1,800 fish in the 1950's (Bjorn 1957). Bull trout harvest was eliminated in 1984, but no positive response in the fishery ensued (Mauser et al. 1988). The bull trout population in Priest Lake is considered functionally extinct while the population in Upper Priest Lake is severely depressed (DuPont et al. In press).

Native westslope cutthroat trout were also historically abundant in Priest Lakes with 30 fish limits common in the 1940's (Mauser et al. 1988). Over harvest, interspecific and intraspecific competition, and degradation of spawning habitat all led to the decline of cutthroat trout in the Priest Lakes. Harvest of cutthroat trout was eliminated in 1988.

In Upper Priest Lake the lake trout population appears to have grown rapidly in the past 25 years. Lake trout were not known to be present in Upper Priest Lake until the mid-1980s at which time they were thought to have begun migrating from Priest Lake (Mauser 1986). In 1998 the Upper Priest Lake lake trout population was estimated at 859 fish (Fredericks and Vernard 1999). In an effort to reduce threats to dwindling bull trout and cutthroat trout populations, Idaho Fish and Game (IDFG) has been using gill nets to reduce lake trout abundance in Upper Priest Lake since 1998. Between 150 and 1,900 lake trout have been removed nearly every year from Upper Priest Lake.

METHODS

Sampling Gear

Harbor Fisheries, Inc. of Baileys Harbor, Wisconsin was contracted to gill net and remove lake trout from Upper Priest Lake in 2008 using their 47 foot commercial gill net boat. Funding for this contract was provided by the USFWS. Gill nets used in Upper Priest Lake were 91 m long by 2.7 m high designed with multiple panels of graded mesh sizes ranging from 64 mm to 89 mm randomly arranged in each net. Individual gill nets were tied together end to end to create a continuous net ranging from 823 m to 16,646 m. Using a variety of mesh sizes reduced the overall effects of size selectivity and allows us to sample fish as small as 150 mm.

Gill nets were fished from June 3 through June 12, 2008. Nets were set throughout the lake and were moved based on catch rates at a particular site and the discretion of the netting crew. Gill nets were set perpendicular to shore when fishing shoreline areas and at various angles when fishing deeper offshore areas. Nets were set at depths ranging from 10 - 31 m. A concerted effort was made to avoid incidental bull trout captures by avoiding areas known to hold concentrations of bull trout.

Data Collection

Two weeks prior to the June removal effort (May 19-20) IDFG used gill nets to conduct a marking run. A total of 33 lake trout were captured, marked with an adipose clip, and released for a Peterson population estimate. During our recapture run lake trout were measured, examined for tags or clips, and killed. Processed lake trout were filleted and given to various food banks throughout the Idaho Panhandle for distribution to the indigent.

Statistical Analysis

Lake trout abundance was estimated from data on numbers of lake trout captured, marked, and recaptured. We used an Adjusted Petersen Estimate (Ricker 1975) to calculate the population size (N).

$$N = \frac{(M+1)(C+1)}{R+1}$$

with a sampling variance of:

$$V(N) = \frac{N^2(C-R)}{(C+1)(R+2)}$$

Where:

M = the number of marked fish,
C = catch or sample taken from the population, and
R = number of recaptured marks in the sample

The Peterson Estimate operates under the following assumptions:

1. Marked fish did not lose their marks.
2. Fish were not overlooked when recaptured.
3. Marked and unmarked fish were equally vulnerable during recapture runs (non-learning behavior).
4. Marked fish must redistribute in the population when released.
5. The population was closed (no movement in or out of study area)
6. No mortality occurred during the estimate.

RESULTS

During our 9-day effort to suppress lake trout abundance in Upper Priest Lake we averaged 5,974 m net/day. A total of 2,207 lake trout were caught and removed. Daily catch of lake trout ranged from 93 - 521 fish. Lake trout ranged from 124 - 916 mm with a mean of 390 mm total length (Figure 4).

A total of thirteen bull trout were capture and released alive. Bull trout ranged from 200-751 mm with a mean length of 511 mm. A 200 mm bull trout is the smallest bull trout collected in recent years. Two adult kokanee were captured, each fish measured 320 mm.

Catch rates of lake trout varied among locations and days in Upper Priest Lake during June, 2008. Catch rates were generally higher along shorelines and lower in deeper mid-lake sets. Catch rates were generally higher at the start of the effort and tapered off over the 10-day sample period (Figure 5).

Using a Leslie Depletion Model (Ricker 1975) we estimated lake trout population abundance at 2,278 fish (Figure 6). This suggested we may have removed up to 92% of the lake trout in Upper Priest Lake.

Fourteen lake trout were recaptured during our removal effort. Our Peterson mark-recapture population estimate for Upper Priest Lake was 5,359 lake trout indicating we may have captured and removed 43 percent of the lake trout in Upper Priest Lake in our 9-day effort.

DISCUSSION

The lake trout population in Upper Priest Lake has grown rapidly in the last decade. In 1998 the lake trout population was estimated at 859 fish (Fredericks 1998). Density of the lake trout (4.07 - 9.5 adults/ha) in 2008 in Upper Priest Lake was average as compared with other North American populations (mean = 4.35 adults/ha, range 0.87 - 14.21; Hansen et al. In press). The range of 4.07 - 9.5 adults/ha was a function of which abundance estimator was used. The density of lake trout in Lake Pend Oreille was estimated at (0.28 adults/ha) in 2006. This seems low; however, the percent of surface area suitable for lake trout in Lake Pend Oreille is probably around 50%. Whereas in Upper Priest Lake nearly 100% of the surface area could be considered usable lake trout habitat.

Duplicating our 2007 effort and comparing results of the two studies provides us with an estimate of how many lake trout are immigrating into Upper Priest Lake on yearly basis. In 2007 we captured and removed 1,982 lake trout from Upper Priest Lake. In 2007 lake trout population abundance was estimated at 2,307 using a Leslie Depletion Model and 3,702 using a Peterson mark-recapture estimate. With the identical technique and similar effort in 2008 we captured and removed 2,207 lake trout and estimated the population abundance at 2,278 using the Leslie Depletion Model and 5,359 using the Peterson mark-recapture estimate. Duplicating the effort tells us two things: not only are we effective at removing a significant portion of the lake trout population in a very short amount of time but we also now have a better idea of how fast Upper Priest Lake is re-populated with immigration from Priest Lake. We estimate that over 2,000 lake trout emigrated from Priest Lake into Upper Priest Lake between July, 2007 and June, 2008.

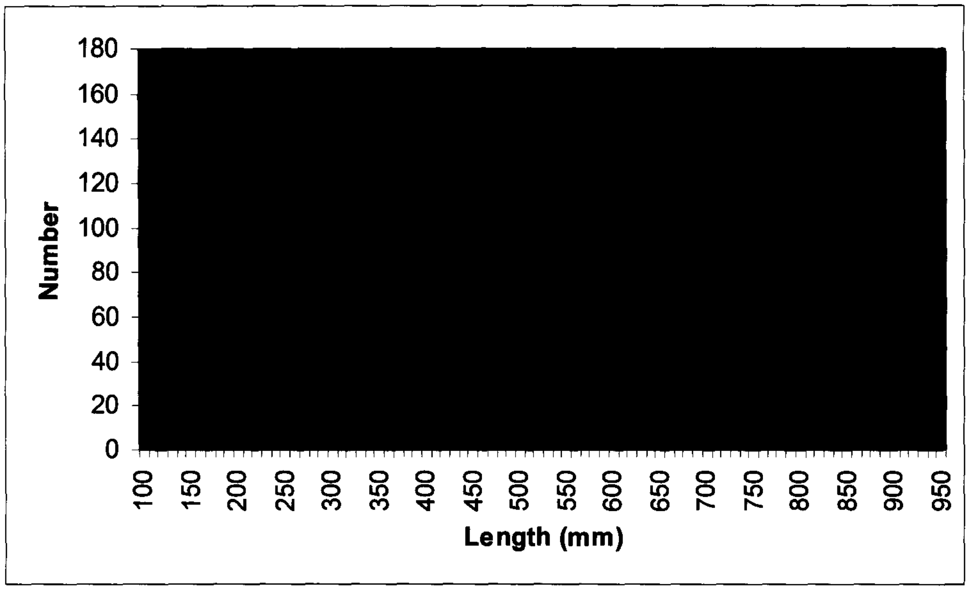

Figure 4. Length frequency of lake trout caught in gill nets in Upper Priest Lake, Idaho, from June 3 through June 12, 2008.

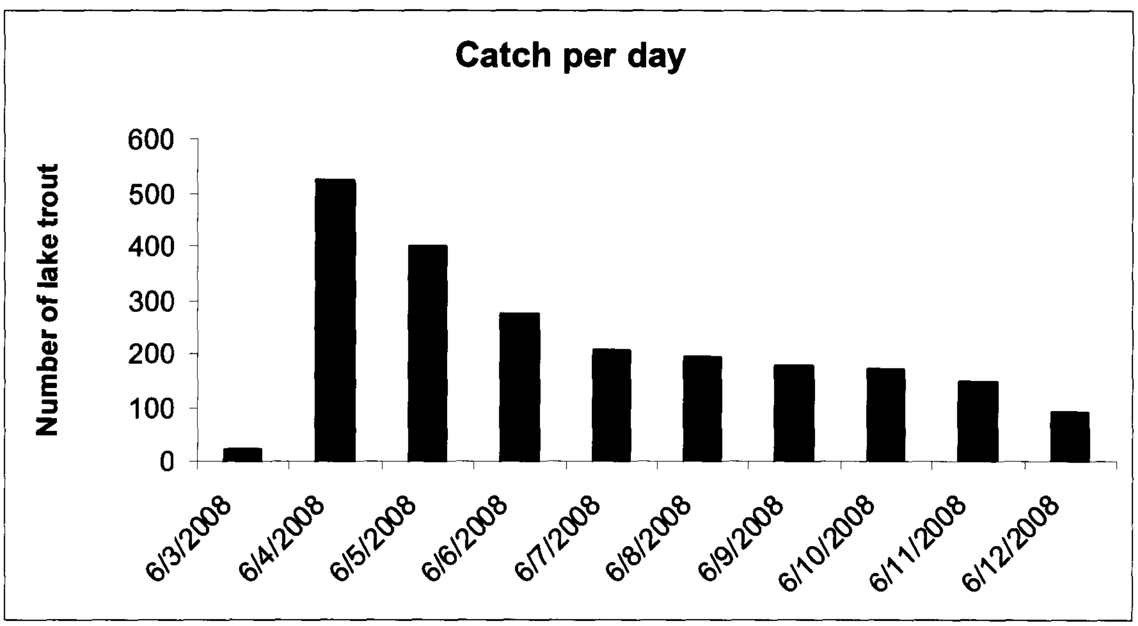

Figure 5. Catch rate of lake trout caught per day over 10 days of sampling by gill nets in Upper Priest Lake, Idaho from June 3 through June 12, 2008.

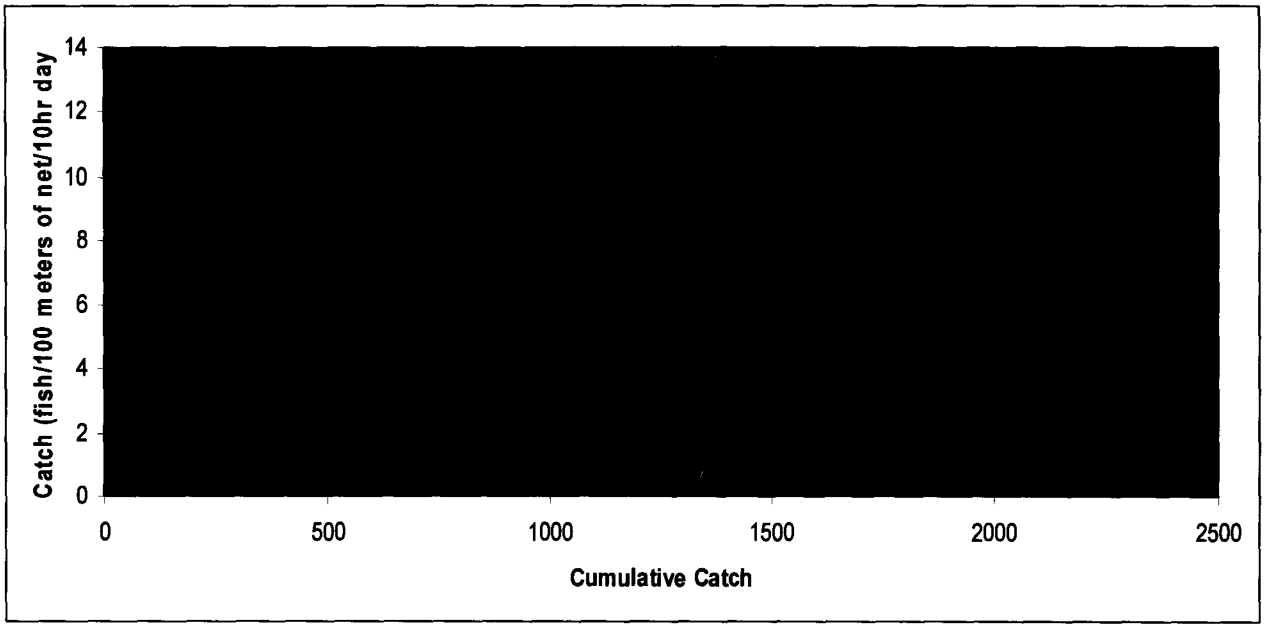

Figure 6. Leslie Depletion Model (Ricker 1975) abundance estimate for lake trout captured by gill nets in Upper Priest Lake, Idaho from June 3 through June 12, 2008.

SPIRIT LAKE KOKANEE POPULATION STUDIES

ABSTRACT

We monitored the kokanee population in Spirit Lake on July 3, 2008 using a midwater trawl. Age-3 kokanee density was 96 fish/ha with a population estimate of 56,400. We estimated 282,000 age-0; 274,000 age-1; and 189,000 age-2 kokanee for a total population estimate of 801,000 fish in 2008. The standing stock of kokanee in Spirit Lake was estimated at 39 kg/ha. We estimated the lake contained 50,600 mature kokanee with a potential egg deposition of 9.4 million eggs.

We also monitored the kokanee population using a split beam echosounder six days after the trawling was conducted. We estimated the lake contained 554,000, 293,000, 199,000, and 61,000 kokanee of ages 0 to 3, respectively. Higher numbers of age-0 kokanee were recorded in the hydroacoustic survey since fry were oriented in shallower waters on the west end of the lake where trawling could not be conducted and many fry were small enough to pass through the trawl net. We also estimated the lake contained a standing stock of 42 kg/ha with a production rate of 22.4 kg/ha/year. Potential egg deposition was estimated at 10.2 million eggs. The acoustic estimate reinforces our understanding that no kokanee stocking is needed at the present time.

Temperature and oxygen profiles were recorded on August 25, 2008. Hypolimnetic oxygen dropped below 4 mg/l at depths below 13 m, which was noticeably lower than when oxygen profiles were last measured in 1982. Epilimnetic temperatures remained a relatively cool 19.8° C to 18.7° C from the surface to a depth of 7 m. Metalimnetic temperatures ranged from 18.7° C to 8.5° C with oxygen ranging from 9.9 to 5.5 mg/l. Thus, kokanee had ample areas of cool water with high oxygen content during mid summer. The low oxygen levels in the hypolimnion, however, should be monitored in future years.

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INTRODUCTION

IDFG transplanted kokanee from Lake Pend Oreille to Spirit Lake in the 1930's and 1940's. These fish originated from Lake Whatcom, Washington, and are "late spawners" that typically spawn during November through early January on shoreline gravel rather than in tributary streams (Winans et al. 1996). Of the 28 kokanee fisheries in northern Idaho, Washington, Oregon, Montana, Utah, Colorado, and British Columbia, listed by Rieman and Myers (1990), Spirit Lake had the highest yield of kokanee (12.7 kg/ha) of any lake. Concerns were raised by anglers during the winter of 2007-08 and the spring of 2008 that the kokanee fishery had declined. We monitored this population in the summer of 2008 to see if the kokanee population had declined in abundance, and to determine if the reduction in the kokanee creel limit from 25 fish to 15 was benefiting the population.

STUDY SITE

Spirit Lake is located near the town of Spirit Lake in the northern panhandle of Idaho. It has a surface area of 598 ha, with 585 ha of kokanee habitat. Maximum depth of the lake is about 27 m.

For northern Idaho, Spirit Lake is a fairly rich body of water. Chlorophyll 'a' was measured at 5.3 µg/l (Soltero and Hall 1984), total phosphorus was 18 µg/l, Secchi transparency was 3.9 m, conductance was 240 µmhos/cm^2, and the morphoedaphic index was 22.0 (Rieman and Myers 1990). This lake also carried the highest biomass of kokanee in northern Idaho at 54.5 kg/ha (Rieman and Myers 1991).

Kokanee in Spirit Lake are mostly naturally reproducing. During the last generation of kokanee (last 4 years), early spawning kokanee were stocked in 2007 (163,260 fry) and in 2008 (168,741 fry).

METHODS

Trawling

We used a midwater trawl, as described by Bowler et al. (1979), Rieman and Meyers (1990), and Rieman (1992), to estimate the kokanee population in Spirit Lake. Five trawl hauls were made in Spirit Lake on July 3, 2008. Trawl transects were selected using a systematic sample design and were in identical locations (as near as possible) to those used in previous years (Figure 7). Kokanee were measured and weighed, and scales were collected from representative length groups for age analysis. The average number of eggs produced per female kokanee was calculated using the regression of kokanee length to fecundity found in Rieman (1992). Ninety percent confidence limits were placed on the arithmetic mean density estimates using a Student's *t* distribution.

Hydroacoustics

A hydroacoustic survey was conducted on Spirit Lake on July 9, 2008. This was the third time that a hydroacoustic survey was conducted on this water body. We used a Simrad EK 60 scientific echosounder with a 6.5° transducer. The transducer was mounted on a pole on the port side of the boat and pointed straight down. The boat traveled at 5.1 km/hr while surveying the lake in a zig-zag pattern (Figure 7).

Kokanee densities were estimated by echo integration. We used EchoView software version 4.40 to calculate nautical area scattering coefficients (NASC) and mean target strengths (in situ). NASC values were calculated by drawing a box around the kokanee layer on the volume backscattering (Sv) fileset and having the software integrate backscattering in this region with a minimum threshold of -60 dB. Age-0 kokanee densities were calculated directly from the echograms by including all targets between -60 dB and -46.0 dB. To calculate the density of age-1 to 3 kokanee, we multiplied the hydroacoustic density estimate of targets between -45.9 dB and -33.0 dB by the percentage of kokanee in each age class in the trawl catch. We calculated the geometric mean density estimates (log x+1) for each age class and used the log transformed data for the population estimate and confidence interval.

We calculated the biomass, production, and mortality (by weight) of the kokanee population in Spirit Lake based on the 2007 and 2008 annual hydroacoustic estimates split into age classes based on trawl catch. Biomass was the total weight of kokanee within the lake at the time of our population estimate. It was calculated by multiplying the population estimate of each kokanee year class by the mean weight of kokanee in that year class as determined in the trawl catch. The year class weights were summed to determine the lake's overall kokanee biomass and divided by the area of kokanee habitat to determine standing stock.

Kokanee production was defined as the weight of flesh grown by the kokanee population regardless of whether the fish was alive or dead at the end of the year (Ricker 1975). We used the Summation Method developed by Newman and Martin (1983) and presented in Hayes et al. (2007), where :

$$\hat{P} = \overline{N} \ \Delta \overline{w}$$

where $\hat{P}$ = production estimate for a kokanee cohort between years one and two, $\overline{N}$ = estimated mean abundance of the cohort between years one and two, and $\Delta \overline{w}$ = estimated change in mean weight of individuals of the cohort from year one to year two. Total annual production of kokanee was calculated as the sum of the production of each cohort.

We defined kokanee mortality by weight as the weight of kokanee flesh that was lost from the population due to all forms of mortality between years. We calculated mortality by weight as:

$$\hat{A}_{wt} = \overline{w} \ \Delta \mathbf{N}$$

where $\hat{A}_{wt}$ = estimated annual mortality of a kokanee cohort for a year by weight, $\overline{w}$ = the mean weight of kokanee between years one and two within the cohort, and Δ **N** is the change in the estimated number of kokanee in a cohort between years one and two (the number lost from a cohort). Results were summed across all cohorts to estimate total weight of all kokanee that died during the year.

We calculated the 90% confidence interval around the geometric mean density estimates for age-0 kokanee and for ages 1 through 3. This was done by transforming the density estimates ($\log_{10}$ X+1) and calculating the error bound using the Student's *t* value for n=7, then untransforming the data.

Limnology

We conducted a limnological survey to examine water quality on August 25, 2008. Sampling was conducted near the center of the lake (Figure 7). Zooplankton was sampled using two vertical tows (each) with 500 µm and 750 µm half meter nets. Nets were lowered to near the bottom in 18 m of water and pulled to the surface at about 0.5 m/s. Weights of zooplankton caught in each net were averaged for each net size, and the catch in the larger mesh net was divided by the catch in the smaller mesh net to calculate a zooplankton cropping ratio (ZPR). Temperature and oxygen were measured with a Yellow Springs Instrument Company Model 85 meter that was calibrated prior to the survey. Water transparency was measured with a 20 cm diameter black and white Secchi disc.

RESULTS

Trawling

By trawling, we estimated the lake contained 281,600 age-0 kokanee (±60%, 90% C.I.); 274,400 age-1 kokanee; (± 37%), 188,800 age-2 kokanee (± 69%); and 56,400 age-3 kokanee (± 86%), with a total population of 801,200 kokanee (± 25%) (Table 2). Density of age-3 kokanee was calculated at 96 fish/ha. Modal sizes of kokanee for each age class were 30 mm, 130 mm, 190 mm, and 230 mm for ages 0 to 3, respectively (Figure 8). The largest kokanee caught was a 256 mm mature female fish. Standing stock of the kokanee population was estimated at 38.8 kg/ha with a total biomass of 22.7 metric tonne (t).

The size at which kokanee matured was about 220 mm (two fish under this size were mature and two fish over this size were immature). We calculated the lake contained 50,600 kokanee over 220 mm. Using a mean length of spawners of 230 mm (assumes no growth between July and November), 371 eggs/female, and a 1:1 sex ratio, we estimated kokanee in Spirit Lake had a potential egg deposition of 9.4 million eggs.

Hydroacoustics

By hydroacoustics, we estimated the lake contained 553,500 age-0 kokanee (90% confidence interval from +45% to -31 %). We also calculated the lake contained 552,000 age 1 through 3 kokanee (90% confidence interval from +47% to -32 %). We then estimated the lake contained 292,500 age-1 kokanee; 198,700 age-2 kokanee; and 60,700 age-3 kokanee based on the percentage of each age class in the trawl catch (Table 3). Density of age-3 kokanee was calculated at 104 kokanee/ha.

Two size groups of kokanee were noted based on target strengths, which corresponded to fry and all other age classes (Figure 9 and 10). Based on this distribution, and the break between fry and age-1 kokanee in the trawl catch, we divided fry from older age classes of kokanee at -46.0 dB. The modal length of fry was -55 dB or about 30 mm (Love 1971). This agrees very well with the modal size of fry in the trawl catch, which was also 30 mm. Kokanee production was estimated at 13.1 t (22.4 kg/ha/yr) for the lake. Biomass of kokanee was 24.4 t (41.6 kg/ha), and mortality by weight was 7.4 t (12.6 kg/ha/yr). Based on these numbers, a production to biomass ratio was 0.54:1. Nautical area scattering coefficient (NASC) estimate for the lake was 505 m^2/nautical mile^2 (Figure 11) which compares favorably to other north Idaho lakes (Figure 12).

Limnology

During our August 2008 limnology survey, we found that the lake was strongly stratified with a thermocline at 7.3 m to 10 m (Table 4). Dissolved oxygen in the hypolimnion dropped below 4 mg/l (Figure 13). Secchi transparency was measured at 5.9 m.

Our zooplankton tows caught 0.297 g and 0.181 g of plankton in the 500 µm net and 0.138 g and 0.046 g in the 750 µm net. ZPR was therefore calculated at 0.38 indicating a moderate amount of cropping of the larger zooplankton. Most of the larger zooplankton in the 750 µm net were *Leptodora kindti.*

DISCUSSION

Kokanee abundance

Kokanee fisheries seem to optimize at 30 to 50 adults/ha (Rieman and Maiolie 1995). Within this range, kokanee density and size-dependant catchability tend to maximize the angling effort, catch rate, and yield. By trawling, we estimated Spirit Lake contained 96 age-3 kokanee/ha (± 86%). Hydroacoustic methods resulted in a very similar estimate of 103 age-3 kokanee/ha. This would indicate kokanee densities may be higher than desired, possibly resulting in smaller kokanee that had lower catchability. However, based on kokanee density we would have still expected a fair to good fishery during winter and summer of 2008. These data do not support the concerns of anglers that kokanee numbers were down.

Kokanee regulations were reduced from 25 fish to 15 fish in 2000. This seemed to have the desired effect as kokanee numbers rebounded by the next population estimate in 2005 (Table 2). With the return to higher kokanee abundance it may be possible to have more liberal harvest regulations. The danger would be that this could again drive kokanee densities down requiring future restrictive regulations. Whether or not this would happen depends on the amount of exploitation on this stock. We therefore recommend examining exploitation rates particularly during the winter ice fishery, which at times was a major source of harvest.

Both trawling and hydroacoustics indicated a strong year class of age-2 kokanee. Age-2 kokanee were mostly 180 to 190 mm in total length, which is considerably smaller than the 210 to 240 mm lengths measured between 1981 and 1991 (Rieman and Myers 1990; Rieman 1992). These fish will be the bulk of the fishery in 2009. If survival rates remain favorable, we would expect adult abundance to be even higher in 2009, with adults maturing again at a small size.

The hydroacoustic survey showed a considerably higher density of kokanee fry than were found by trawling. Trawling could have underestimated fry abundance due to net avoidance, fry passing through the net, and lack of sampling in the near-shore areas of the lake. In particular, hydroacoustic surveys showed the highest fry density at the western end of the lake (2,070 fry/ha) in water that would be difficult to trawl. We believed the hydroacoustic estimate was the more accurate of the two estimates, which suggested fry abundance remained high in 2008 (mean of 946 fry/ha). The winter of 2007-08 was a high snow pack year. It was encouraging that fry abundance was not overly reduced by losses of kokanee out of the lake.

Supplemental stocking of kokanee (the addition of hatchery kokanee into a reproducing wild population) has been a management practice in Spirit Lake. This was done in an attempt to even out fluctuations in the fishery. We recommend kokanee supplementation be considered as a management option when two conditions are met. First, when fry abundance drops below 500 fry/ha as measured by hydroacoustics (at a conservatively high mortality rate of 60%, 500 fry/ha would yield an adult population of 32 age-3 kokanee/ha). Secondly, when the lake's standing stock is less than about 30 kg/ha, giving the additional kokanee room to grow without impacting other age classes.

Kokanee Production

Kokanee production for Spirit Lake was estimated at 22 kg/ha/yr between 2007 and 2008. This is roughly twice the kokanee production of Lake Pend Oreille (8 to 11 kg/ha/yr between 1995 and 2007, agency files). Spirit Lake therefore remained a very productive lake for growing kokanee.

NASC values are a sum of the backscattering of fish in the analyzed layer and should be an index of fish biomass (Simmonds and MacLennan 2005). Figure 11 compares NASC values for kokanee surveys for several lakes in Idaho. These data suggested Spirit Lake had a relatively high biomass for waters in northern Idaho (Figure 11). We recommend continuing to develop the relationship between NASC and kokanee biomass (Figure 12). If this relationship proved to be consistent, hydroacoustic surveys, without trawling, could be used to index both kokanee biomass and fry abundance. With these two pieces of information, fishery managers could decide if stocking additional kokanee fry is warranted. This would be particularly helpful in years when the lake level is low in mid-summer and the trawler cannot be launched at the boat ramp.

Limnology

Our surveys during the summer of 2008 documented dissolved oxygen values in the hypolimnion that were below 4 mg/l (Figure 13). A survey on August 23, 1982 found much higher dissolved oxygen levels of 6 to 10 mg/l in the hypolimnion (Rieman and Horner 1984) (Figure 13). We were therefore concerned that land use and development in the drainage may be enriching the lake causing the loss of this deep water habitat for salmonids during mid-summer.

MANAGEMENT RECOMMENDATIONS

1. Re-examine the 15 fish kokanee limit on Spirit Lake. If the winter exploitation is low, raising the harvest limits could be considered in the next regulation cycle.

2. Monitor dissolved oxygen levels under the winter ice cover and during summer to determine if increased nutrient loading is affecting fish habitat.

3. Stock kokanee fry only when fry abundance drops below 500 fry/ha based on hydroacoustics, and the lake's standing stock drops below 30 kg/ha. Subsequent monitoring should be conducted to evaluate the effectiveness of the stocking.

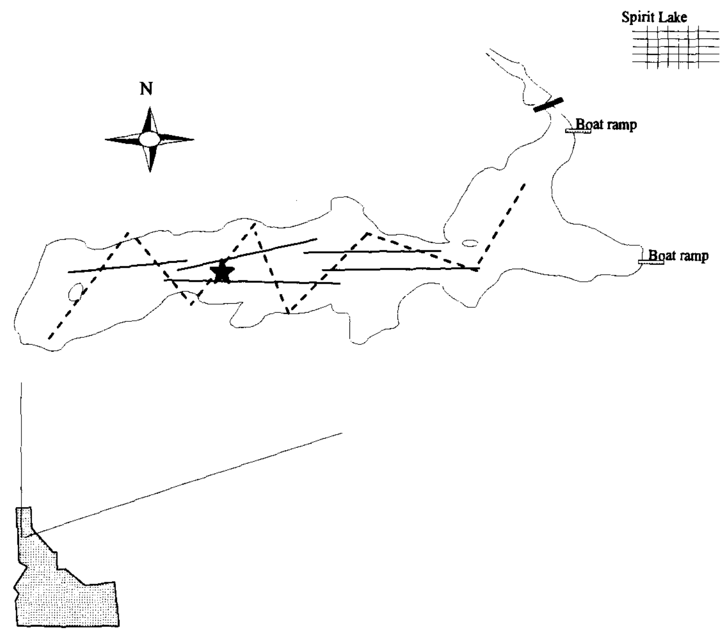

Figure 7. Location of five midwater trawling transects (solid lines) and seven hydroacoustic transects (dashed lines) used to estimate kokanee population abundance in Spirit Lake, Idaho during 2008. Star indicates the location of the limnological sampling.

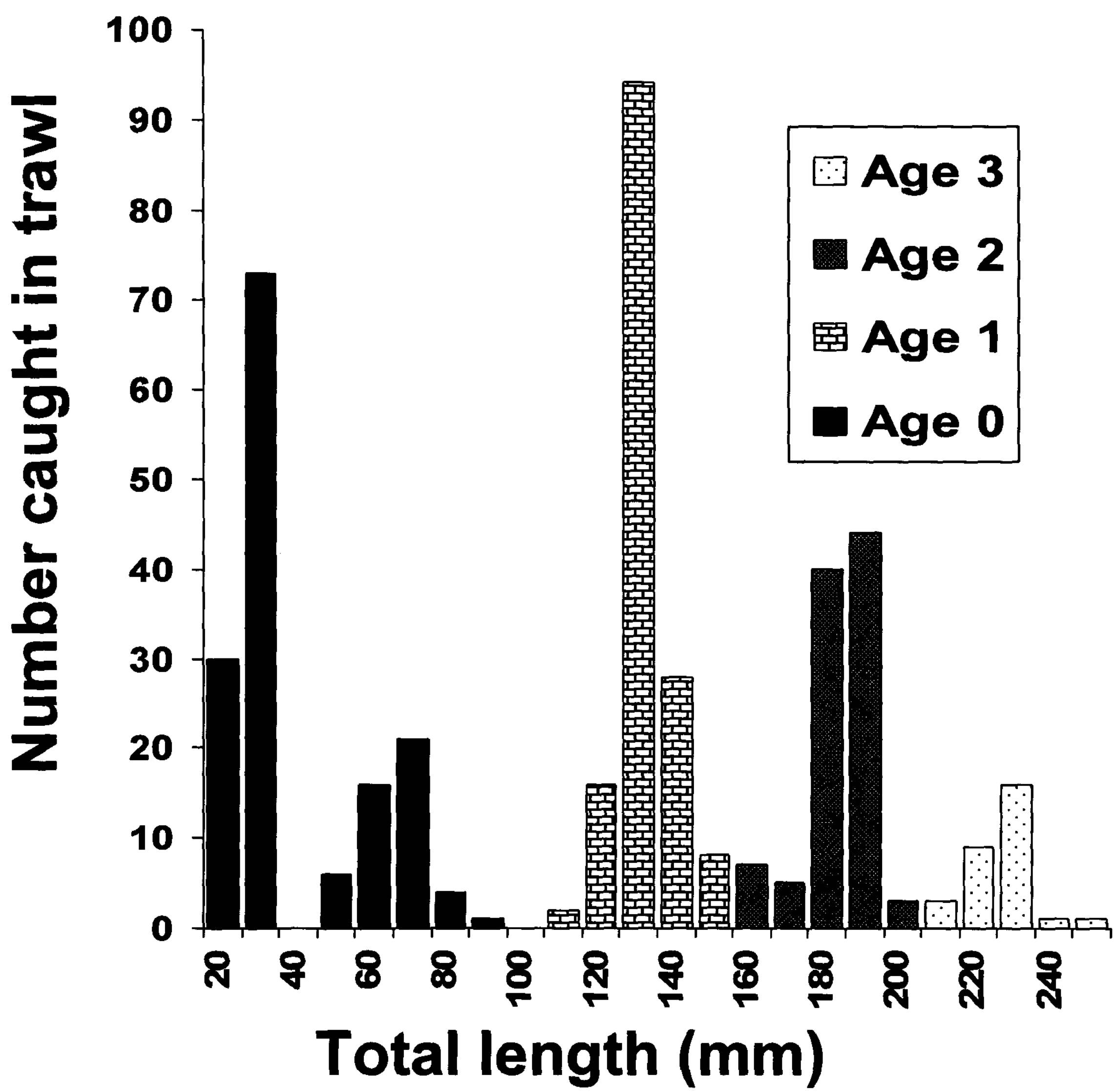

Figure 8. Length-frequency distribution of kokanee caught while trawling Spirit Lake, Idaho, July 3, 2008. Note that the age-0 kokanee show a bimodal distribution likely due to the presence of larger hatchery fry.

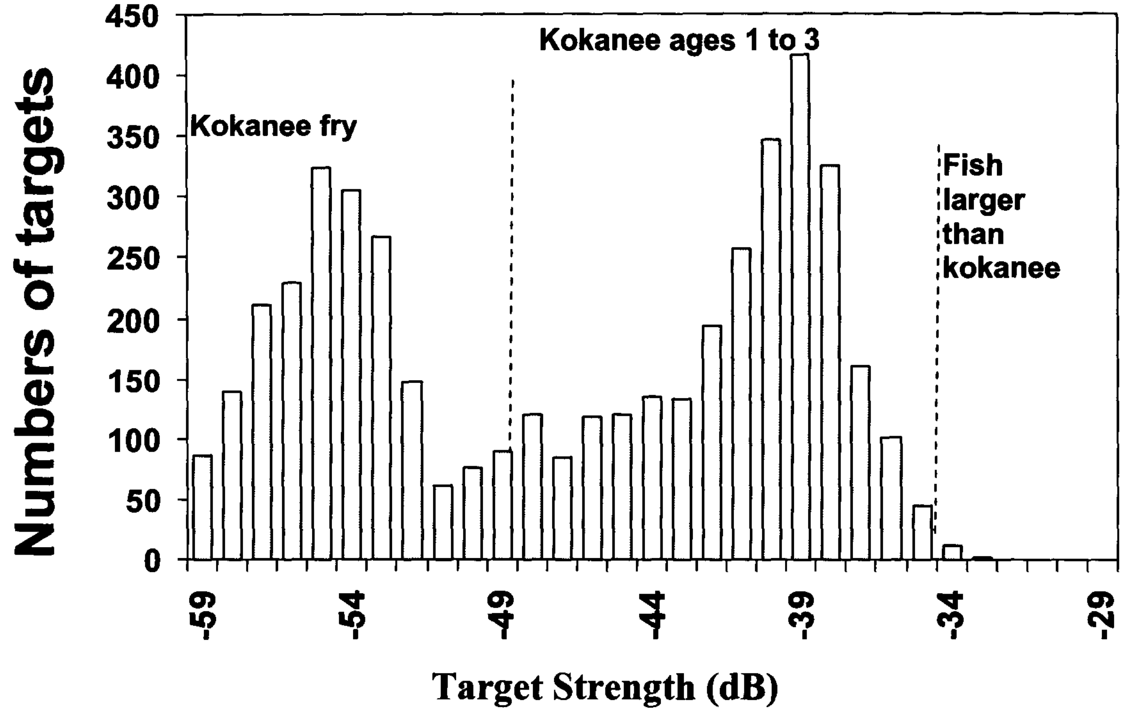

Figure 9. Target-strength frequency distribution of kokanee in Spirit Lake, Idaho, on July 9,2008. Note that the age-0 kokanee show a bimodal distribution likely due to the presence of larger hatchery fry.

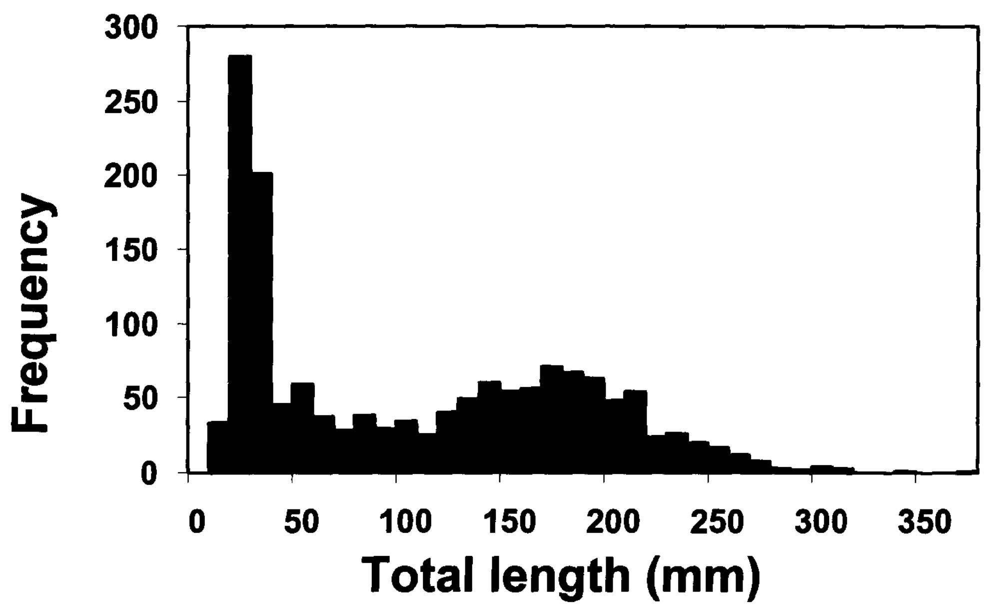

Figure 10. Length-frequency distribution of kokanee based on their target strengths during a hydroacoustic survey on Spirit Lake, Idaho, July 9, 2008. Lengths were calculated based on Love's (1971) equation.

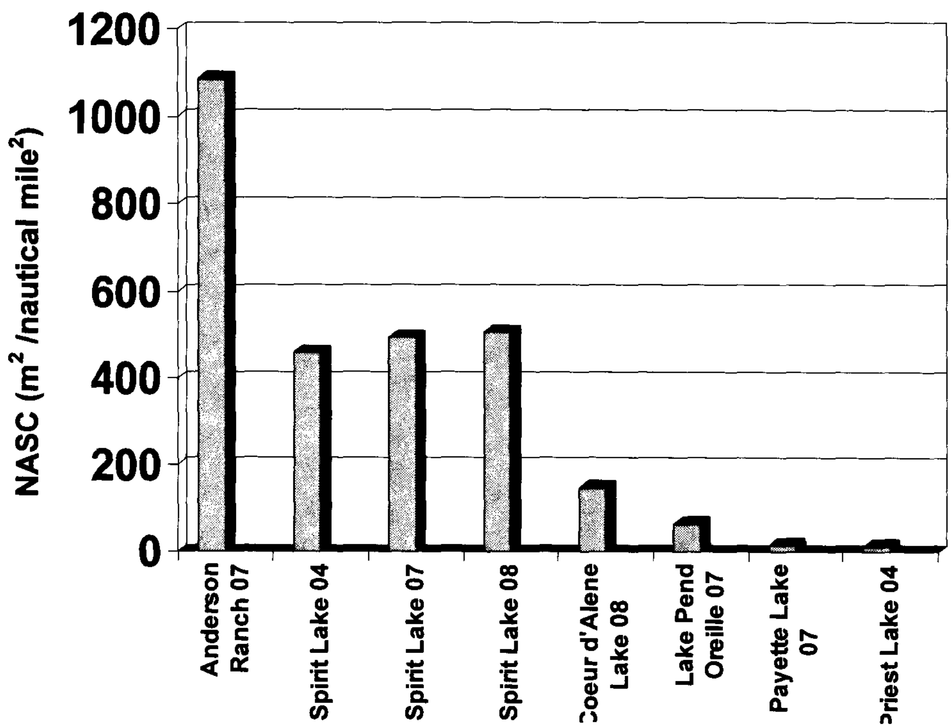

Figure 11. Nautical area scattering coefficients (NASC) for several lake and reservoirs in Idaho.

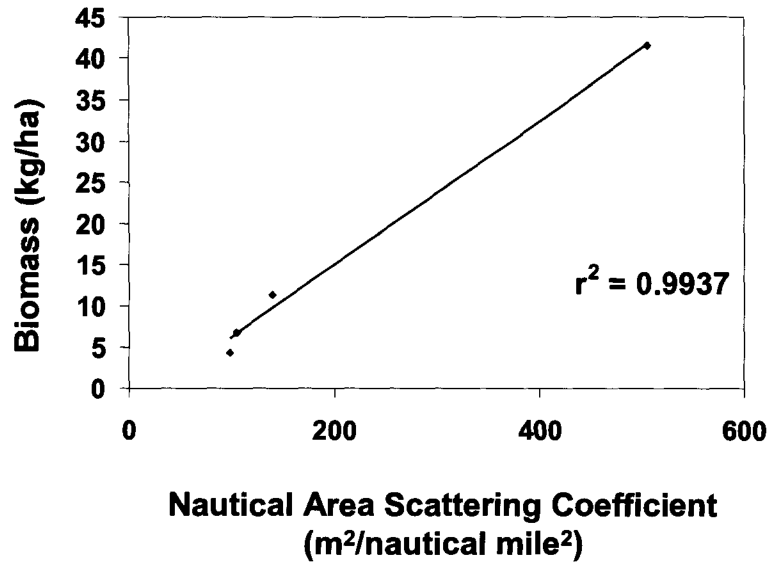

Figure 12. Preliminary relationship between the Nautical Area Scattering Coefficient (NASC) and kokanee biomass. These data were from Lake Pend Oreille (lower three points) and Spirit Lake in 2008 (upper point). Note that the correlation coefficient is based on four points.

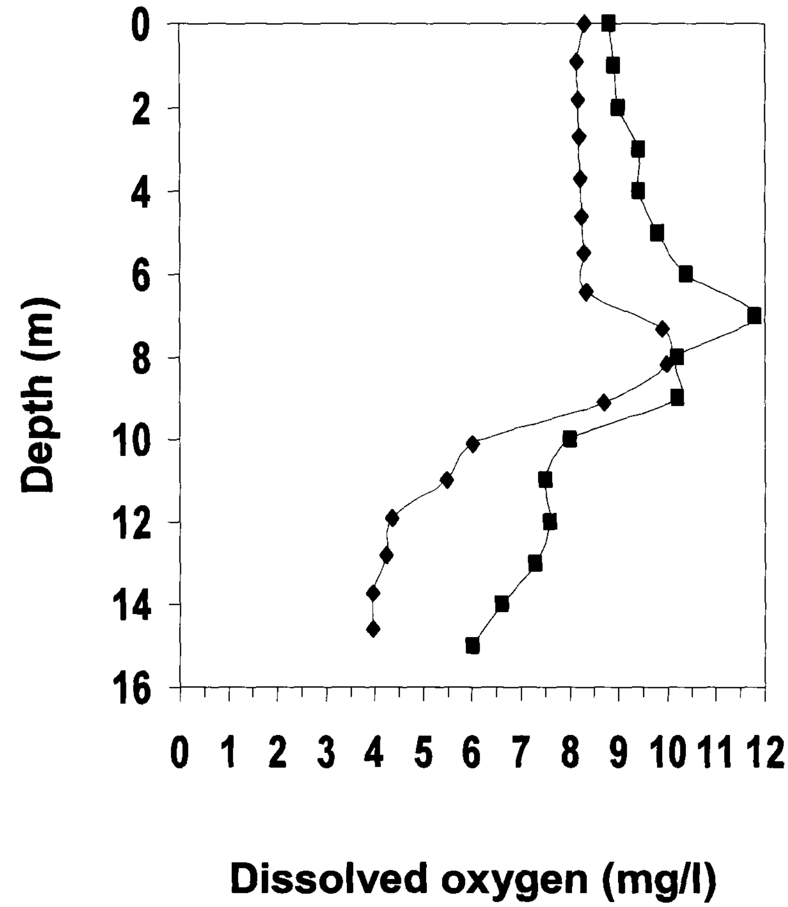

Figure 13. Dissolved oxygen profiles in Spirit Lake, Idaho. Profiles were measured on August 25, 2008 (diamonds) and on August 23, 1982 (squares) (Rieman and Horner 1984).

Table 2. Kokanee population estimates based on midwater trawling from 1981 through 2008 in Spirit Lake, Idaho.

Year	Age Class				Total	Age-3+/ha
	Age-0	Age-1	Age-2	Age-3		
2008	281,600	274,400	188,800	56,400	801,200	96
2007	439,919	210,122	41,460	20,409	711,910	35
2006	-	-	-	-	-	-
2005	508,000	202,000	185,000	94,000	989,100	161
2001-04	-	-	-	-	-	-
2000	800,000	73,000	6,800	7,800	901,900	13
1999	286,900	9,700	50,400	34,800	381,800	61
1998	28,100	62,400	86,900	27,800	205,200	49
1997	187,300	132,200	65,600	6,500	391,600	11
1996	--	--	--	--	--	--
1995	39,800	129,400	30,500	81,400	281,100	142
1994	11,800	76,300	81,700	19,600	189,400	34
1993	52,400	244,100	114,400	11,500	422,400	20
1992	--	--	--	--	--	--
1991	458,400	215,600	90,000	26,000	790,000	45
1990	110,000	285,800	84,100	62,000	541,800	108
1989	111,900	116,400	196,000	86,000	510,400	150
1988	63,800	207,700	78,500	148,800	498,800	260
1987	42,800	164,800	332,800	71,700	612,100	125
1986	15,400	138,000	116,800	35,400	305,600	62
1985	149,600	184,900	101,000	66,600	502,100	116
1984	3,300	16,400	148,800	96,500	264,900	168
1983	111,200	224,000	111,200	39,200	485,700	68
1982	526,000	209,000	57,700	48,000	840,700	84
1981	281,300	73,400	82,100	92,600	529,400	162
Mean abundance from 1981-2005	**199,300**	**145,500**	**106,300**	**55,500**	**507,500**	**89**

Table 3. Kokanee population estimates in 2008 based on hydroacoustic surveys in Spirit Lake, Idaho.

	Age Class						
	Age-0	Age-1	Age-2	Age-3			
Year					Total	NASC	Age 3/ha
2008	553,500	292,500	198,700	60,700	1,105,400	505	103
2007	495,900	266,900	52,500	25,900	841,200	494	44
2004	279,000	-[a]	-[a]	-[a]	916,800	458	-

[a] No trawling was conducted in 2004 to delineate kokanee in age classes 1 to 3.

Table 4. Temperature and dissolved oxygen readings near the center of Spirit Lake, Idaho, August 25, 2008.

Depth (m)	Temp (^oC)	Dissolved oxygen as a percent of saturation	Dissolved oxygen (mg/l)
Surface	19.8	92.5	8.30
0.9	19.8	90.8	8.15
1.8	19.8	90.6	8.17
2.7	19.8	88.5	8.20
3.7	19.8	89.1	8.22
4.6	19.8	88.0	8.24
5.5	19.7	90.0	8.29
6.4	19.5	89.0	8.32
7.3	18.7	90.0	9.89
8.2	12.7	93.3	9.97
9.1	11.3	75.4	8.70
10.1	9.3	52.0	6.02
11.0	8.5	47.4	5.48
11.9	7.7	40.2	4.36
12.8	7.1	36.6	4.25
13.7	6.8	34.2	3.97
14.6	6.5	32.6	3.98

2008 Panhandle Region Fishery Management Report

COEUR D'ALENE LAKE FISHERY INVESTIGATIONS

ABSTRACT

A midwater trawl was used to estimate the kokanee population in Coeur d'Alene Lake on July 28-30, 2008. We estimated that the lake contained 3,035,200 age-0 kokanee; 3,610,400 age-1 kokanee; 1,754,900 age-2 kokanee; and 27,700 age-3 kokanee (3 fish/ha). The fishery for kokanee was closed on September 2, 2008 because of the continued low density of adult kokanee. Standing stock was estimated at 13 kg/ha, with a total biomass of 128 t. Production was estimated at 11.0 kg/ha/yr (106 t), mortality by weight was 4.4 kg/ha/yr (42 t), and the population's biomass increased 70 t from last year's estimate. The total egg deposition was calculated at 9.5 million eggs.

For the first time, a hydroacoustic survey was conducted on Coeur d'Alene Lake to estimate kokanee abundance. Based on hydroacoustic density estimates and the percent of each age class caught in the trawl, we estimated 10,277,000 fry; 2,133,000 age-1 kokanee; 839,000 age-2 kokanee; and 26,000 age-3 kokanee. The highest density of fry was found in Wolf Lodge Bay where one transect recorded 14,800 fry/ha.

We used a helicopter to conduct Chinook salmon redd *O. tshawytscha* surveys in the Coeur d'Alene River and St. Joe River drainages. We counted 88 redds in the main stem of the Coeur d'Alene River, 0 redds in the Little North Fork Coeur d'Alene River, 4 redds in the South Fork Coeur d'Alene River, and 17 in the St. Joe River, for a total of 109 redds. A total of nine Chinook salmon redds were excavated to reduce natural production in the Coeur d'Alene Lake basin to 100 redds. No age-0 hatchery Chinook salmon were stocked in Lake Coeur d'Alene in 2008.

During June 2008 we examined the stomach contents of 55 smallmouth bass. Kokanee comprised 12% of the diet of individual smallmouth bass by weight and were the third most important item after sculpin *Cottus sp.* and mayfly nymphs. Fish identifiable as kokanee ranged from 63 to 133 mm and were likely ages 1 and 2.

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INTRODUCTION

Kokanee are one of the most important sport fish species in the Panhandle Region. Populations have been established in all the larger lakes in the Region and are stocked into several of the smaller lakes as well. Kokanee first established in Lake Pend Oreille in the 1930's by emigrating down the Clark Fork River from Flathead Lake, Montana. Kokanee were stocked into Flathead Lake in 1916 and were originally from wild stocks from Lake Whatcom, Washington. Once kokanee were established in Lake Pend Oreille, IDFG transplanted them to Coeur d'Alene, Spirit, and Priest Lakes in the 1930's and 1940's. Self sustaining populations were soon established and kokanee fisheries typically provided 50% to 90% of the angling effort in the large northern Idaho lakes. The Lake Whatcom stock of kokanee are described as "late spawners" typically using shoreline gravel rather than tributary streams and spawning from November through early January.

The kokanee fishery in Coeur d'Alene Lake peaked in 1979 with 578,000 fish harvested but then quickly declined by the early 1980's when kokanee became very numerous and mean size decreased. Fall Chinook salmon were introduced into Coeur d'Alene Lake in 1982 as a biological tool to reduce kokanee abundance and improve the fishery. Fall Chinook salmon were chosen as the preferred predator to reduce kokanee numbers for a variety of reasons: their relatively short and semelparous life cycle compared to other species (lake trout, Kamloops rainbow trout, walleye, brown trout); ability to manage predator numbers; and the benefit provided by a Chinook salmon fishery. Chinook salmon have established a naturally reproducing population by spawning in the Coeur d'Alene and St. Joe river systems. Both naturally produced and hatchery stocked Chinook salmon are used to achieve management goals.

Adult kokanee densities have remained below the desired range of 30 to 50 fish/ha since 1997. Based on trawling, age-3 kokanee densities were below 10 fish/ha in seven of the last nine years, and were at 3 fish/ha in 2006 and 2007. Our concern is that Chinook salmon predation is impacting, rather than benefiting, the kokanee fishery. This report covers IDFG's efforts to monitor kokanee and Chinook salmon in 2008, and manage both populations to improve the sport fishery in Coeur d'Alene Lake.

OBJECTIVE

The current objective is to manage Coeur d'Alene Lake for a kokanee yield fishery and limited Chinook salmon trophy fishery. Densities of 30-50 age-3 kokanee/ha served as a guideline to provide the highest combination of catch rate, yield, and fishing effort (Rieman and Maiolie 1995). Chinook salmon management direction called for greater catches of 1.5-9 kg fish rather than fewer but larger fish (IDFG 2007).

STUDY AREA

Coeur d'Alene Lake is located in northern Idaho near the town of Coeur d'Alene. It is a natural lake of 12,742 ha with 9,648 ha of pelagic habitat used by kokanee. The native sportfish within the lake include bull trout, westslope cutthroat trout, and mountain whitefish. Introduced fish species included kokanee, Chinook salmon, rainbow trout *O. mykiss*, brook trout, brown trout *Salmo trutta*, largemouth bass, smallmouth bass, pumpkinseed *L. gibbosus*, bluegill *L. macrochirus,* green sunfish, yellow perch, black crappie *Pomoxis nigromaculatus*, brown bullhead *Ameiurus nebulosus*, black bullhead *A. melas*, channel catfish *Ictalurus punctatus*, and northern pike. Kokanee were stocked in 1937 and later years, and provided a peak harvest of 578,000 kokanee in 1979 based on a lakewide angler use survey (Rieman and LaBolle 1980). Coeur d'Alene Lake was the most heavily fished water in Idaho during 2003 largely because of its kokanee fishery. Fall Chinook salmon were introduced in 1982 to reduce the abundance of kokanee and provide an additional fishery. Salmon reproduce naturally in the Coeur d'Alene River and St. Joe River drainages and are also supplementally stocked in most years.

METHODS

Kokanee Estimates by Trawling

We used a midwater trawl, as described by Bowler et al. (1979), and Rieman (1992), to estimate the kokanee populations in Coeur d'Alene Lake. Twenty-one transects were trawled on Coeur d'Alene Lake during the dark phase of the moon on July 28-30, 2008. Trawl transects were in the same locations as previous years with one exception. One transect at the northern end of the lake was repositioned so that it did not cross another transect (Figure 14). Data were analyzed as a stratified systematic sampling design. Densities of kokanee within each lake section were averaged to determine an arithmetic mean and multiplied by the area of that section to determine the section's abundance. Kokanee were measured and weighed, and scales and otoliths were collected from representative length groups for age analysis.

Because trawling was conducted in July and because Coeur d'Alene Lake kokanee may grow substantially between August and late November when they spawn, experimental gill nets were used to capture adults during spawning. Kokanee spawner lengths were determined by collecting a sample of fish on December 5, 2008. The gill net was set near Higgins Point for about 40 min. Potential egg deposition (PED) was estimated as the number of female kokanee spawners (half the mature population based on midwater trawling) multiplied by the average number of eggs produced per female. The average number of eggs produced per female kokanee was calculated using the following length to fecundity regression (Rieman 1992):

$$Y = 3.98x - 544$$

Where: x =mean length of female kokanee spawners (mm)
Y =mean number of eggs per female

Kokanee Estimates by Hydroacoustics

We conducted a lake-wide, mobile, hydroacoustic survey on Coeur d'Alene Lake to monitor the kokanee population. To our knowledge this is the first such survey done on this lake. Survey was made at night on August 5-7, 2008. We used a Simrad EK60 split-beam, scientific echosounder with a 120 kHz transducer to estimate kokanee abundance. Ping rate was set at 0.2 or 0.3 s/ping, depending on water depth. A pole-mounted transducer was located 0.75 m below the surface, off the port side of the boat, and pointed downward. The echosounder was calibrated prior to the survey using a 23 mm copper calibration sphere to set the gain and to adjust for signal attenuation to the sides of the acoustic axis. We used Simrad's ER60 software to determine, and input, the calibration settings.

We followed a uniformly spaced, zigzag pattern of transects traveling from shoreline to shoreline (Figure 14) (MacLennan and Simmonds 1992). The starting point of the first transect in each section was chosen randomly. Boat speed was approximately 1.3 m/s (boat speed did not affect our calculations of fish density).

We determined kokanee abundance using echo integration techniques. SonarData's Echoview software, version 4.40.71, was used to view and analyze the collected data. A box was drawn around the kokanee layer on each of the echograms and integrated to obtain the nautical area scattering coefficient (NASC) and analyzed to obtain the mean target strength of all returned echoes. This integration accounted for fish that were too close together to detect as a single target (MacLennan and Simmonds 1992). Densities were then calculated by the equation:

$$\text{Density (fish/ha)} = (\text{NASC} / 4\pi 10^{TS/10})\ 0.00292$$

where:

NASC is the total backscattering in m^2/nautical $mile^2$, and
TS is the mean target strength in dB for the area sampled.

To determine a population estimate for kokanee, we first log transformed [log (x+1)] the density estimates and calculated a geometric mean density for each lake section. We then multiplied the geometric mean density of kokanee for each lake section by the area of each lake section. Abundance in each of the three sections was summed to estimate the total population.

We used *in-situ* target strengths, and the length-frequency distribution in the trawl catch, to split fry from the older age classes of kokanee. A target strength-frequency distribution showed a bimodal distribution of fry and larger kokanee of ages 1 to 4. We split kokanee fry and older age classes at -47 dB [approximately 80 mm total length (Love 1971)] based on this distribution and the sizes of kokanee collected in the trawl. Fry were therefore defined as all targets between -60 and -47 dB. Kokanee of age classes 1 to 3 were defined as those targets between -46.9 and -33.0 dB. We did not include targets over -33 dB to minimize the chance of including other species in our kokanee estimate. Separate abundance estimates were calculated for fry and for kokanee with combined ages 1 to 4 using the hydroacoustics.

We then partitioned the combined estimate of kokanee ages 1-4 into estimates of each age class. Annual midwater trawling was conducted on the lake 1 week before the hydroacoustic estimate. We multiplied the acoustic estimate within each lake section by the estimated percentage of each age class in that section based on trawling. Section estimates were totaled to obtain a population estimate for the entire lake for each year class.

Efforts were made in 2008 to determine the abundance of age-3 kokanee solely by hydroacoustics. This would eliminate trawl bias in this estimate of larger, faster swimming fish. To do so, we estimated the abundance of fish with target strengths of -37 and -30 (250 mm to 590 mm, based on Love's (1971) equation). We then used the total number of kokanee on each transect as determined by echo integration and determined the percentage of returned pings between -60 and -25 dB that were between -37 and -30 dB. This percentage was multiplied by the total kokanee density for that transect to estimate the density of age-3 kokanee. Density estimates were transformed ($\log_{10}$ x +1) and confidence intervals were calculated on the transformed data by formula for stratified random sampling designs.

Chinook Salmon Estimates by Hydroacoustics

The hydroacoustic survey conducted on August 5-7, 2008 to estimate kokanee abundance was also examined to estimate the abundance of Chinook salmon. Any large fish with mean target strengths over -30 dB (590 mm) were examined as possible Chinook salmon. This size was chosen since it was believed to be large enough to exclude kokanee from the analysis.

In addition, a survey was conducted on December 3, 2008 at the north end of Coeur d'Alene Lake to see if Chinook salmon could be better estimated during winter when they may be deeper in the water column. Five transects, totaling 23 km, were surveyed across the lake between Bennett Bay and Tubbs Hill (Figure 14). This area was known as a good place to fish for Chinook salmon by local anglers. Survey was conducted between 1000 and 1500 hours. Echosounder settings were the same as those used during the August kokanee survey. Any large fish over -30 dB were considered as possible Chinook salmon and closely examined.

Density estimates of Chinook salmon were calculated by a fish counting technique; as opposed to the echo integration technique used for kokanee. The number of Chinook salmon were binned into one m depths, and divided by the total area surveyed on all transects at that depth. The total area surveyed was determined by multiplying the sum of all transect lengths by the athwart beam diameter for a 6.57° beam.

Chinook Salmon Redd Counts

During 2008, IDFG personnel monitored the spawning of wild Chinook salmon. We used a helicopter (Hughes H500 C) to conduct Chinook redd surveys in the Coeur d'Alene River, North Fork Coeur d'Alene River, South Fork Coeur d'Alene River, Little North Fork Coeur d'Alene River and St. Joe River on September 26, 2008. We estimated the natural smolt production from these redds by assuming an estimate of 4,000 eggs per redd, and a mean egg-to-smolt survival of 10%. In an effort to reduce natural production, using shovels, we excavated and destroyed redds to reduce the number to 100.

Smallmouth Bass Food Habits

We collected smallmouth bass from Coeur d'Alene Lake to examine their stomach contents and see if kokanee were an important part of their diet. Fish were collected by electrofishing the north end of Coeur d'Alene Lake (Wolf Lodge Bay area) on June 3, 2008. We also sampled the southern end of the lake near East Point on June 25, 2008. Twenty-eight smallmouth bass stomachs that contained food were collected at the north end and 27 stomachs were collected at the southern end during the June sampling. Additional sampling was tried on October 22, 2008, but few smallmouth bass were collected. Stomachs were placed in ethanol shortly after the fish were collected. Food items were examined under a dissecting scope and each item was weighed.

RESULTS

Kokanee Estimates by Trawling

Based on trawling, we estimated Coeur d'Alene Lake contained 3,035,000 (± 120%), 3,610,000 (± 24%), 1,755,000 (± 52%), and 28,000 (± 89%) kokanee of ages 0,1, 2, and 3, respectively (Tables 5 and 6). Density of age-3 kokanee was calculated at 2.9 fish/ha. Standing stock was estimated at 13.29 kg/ha with a total population biomass of 128 metric t. Survival rates from 2007 to 2008 year were 100%, 74%, and 21% for age-0 to1, 1 to 2 and 2 to 3, respectively.

Kokanee fry collected in the trawl ranged from 34 to 57 mm total length with a modal length of 40 mm (Figure 15). Age-1 kokanee ranged from 82 to 142 mm with a modal length of 120 mm. Age-2 fish ranged from 145 to 251 mm with a modal length of 160 mm. Size of the age-3 kokanee in the trawl catch ranged from 230 mm to 311 mm (Figure 15). Mean weights were 0.7, 15.1, 38.0, and 177.4 g for kokanee age classes 0-3, respectively.

We collected 271 kokanee spawners near Higgins Point in Wolf Lodge Bay in a 40 minute gillnet set on December 5, 2008. Males outnumbered females in the gillnet 268 to 3. Mean length of female kokanee was 309 mm (TL), (n=3). Males averaged 326 mm (n=63). Total length of both sexes was smaller than the previous three years, but remained larger than the sizes seen between 1974 and 1997 (Figure 16). Mean fecundity was estimated at 686 eggs per female based on a mean female spawner length of 309 mm. Based on the trawl catch, kokanee over 260 mm were mature, which corresponded to an age-3 fish. Assuming a 50:50 male to female ratio, the lake contained 13,852 mature females. Potential egg deposition was estimated at 9.5 million eggs. Survival from kokanee eggs in 2007 to fry in 2008 was calculated at 23% (Table 7).

Kokanee Estimates by Hydroacoustics

Based on the hydroacoustic survey, Coeur d'Alene Lake in 2008 contained 10,277,000 kokanee fry (1,065/ha) with a 90% confidence limit of -20% to +26%. Age 1-3 kokanee were estimated at 2,997,000 (311/ha) with a 90% confidence limit of -16% to +19%. Based on the percentage of each age class caught in the trawl in each lake section, we estimated the lake contained 2,133,000 age-1 kokanee (221/ha); 839,000 age-2 kokanee (87/ha); and 26,000 age-3 kokanee (2.6/ha) (Table 8).

The proportion of mature kokanee to kokanee ages 1 to 3 in the trawl catch was 2.75%, 0.39% and 0% in Section 1, 2, and 3, respectively. We multiplied these percentages times the hydroacoustic estimate for kokanee ages 1 to 3 to derive an estimate of mature kokanee of 28,123. As a second estimate of adult kokanee abundance, we estimated the abundance of all targets between -37 dB and -30 dB. We caution that no distinct size group of 3 year old kokanee could be seen on the target strength-frequency distribution so this split could be imprecise (Figure 17). Based on this analysis, we estimated that Coeur d'Alene Lake contained 132,000 age-3 kokanee with a 90% confidence limit of -12% to +14%.

The highest densities of kokanee fry were found at the northern end of the lake particularly near the eastern end in Wolf Lodge Bay (Figure 18). The first three transects, starting with the eastern-most, had 5,600 fry/ha, 14,800 fry/ha and 9,500 fry/ha, respectively. Most of the kokanee spawning occurs along road fills in this bay, and it appeared that most of the fry remained in this bay throughout the summer. We recommend stocking Chinook salmon fingerlings into Wolf Lodge Bay or Wolf Lodge Creek in order to provide them with the highest densities of forage. Stocking at the northern end of the lake would also provide a north-end fishery during the fall when adult Chinook salmon return to spawn.

Chinook Salmon Estimates by Hydroacoustics

On the August 5-7, 2008 hydroacoustic survey, we examined 65,450 returned echoes from fish. Only one fish had a mean target strength of over -30 dB and therefore met our size criteria to be a possible Chinook salmon. This fish had an average target strength of -29.03 dB (661 mm) and was 11.6 m deep (near the top of the kokanee layer).

A population estimate based on only one fish cannot be considered reliable, but was calculated to put these data into perspective. We surveyed 56,592 m of transects. Athwart beam width at the 11.5 m bin depth was 1.32 m. This calculated to 74,701 m^2 surveyed or 7.5 ha. Density was therefore 0.133 possible Chinook salmon/ha, or a population estimate of 1,283 Chinook salmon >590 mm in Coeur d'Alene Lake.

No large fish (>-30 dB) were recorded on the December 3, 2008 survey for Chinook salmon. Numerous schools of kokanee were graphed and some single fish were recorded near the bottom, but none of these targets averaged larger than -33 dB (410 mm) (Figure 19).

Chinook Salmon Redd Counts

We counted 92 Chinook salmon redds in the Coeur d'Alene River drainage and 17 in the St. Joe River (Table 9). Conditions for counting were favorable (clear skies and clear water), and redds were easily seen.

Management goals call for no more than 100 Chinook salmon redds in the Coeur d'Alene Lake drainage. We therefore destroyed nine redds in the Coeur d'Alene River near Kingston on October 8, 2008. We estimated 40,000 smolts would be produced naturally from the remaining 100 undisturbed redds (100 redds times 4,000 eggs per redd times a 10% egg-to-smolt survival rate).

No age-0 hatchery Chinook salmon were stocked in 2008. The total age-0 wild Chinook salmon from 2007 entering Coeur d'Alene Lake in 2008 was estimated to be about 26,000 smolts (Table 10).

Smallmouth Bass Food Habits

Smallmouth bass stomachs contained a variety of food items during the June 2008 sampling effort. Kokanee averaged 12% of the diet of individual fish (Figure 20). Based on total weight, kokanee were 21% of the weight of all of the items eaten by all 55 smallmouth bass. Other items found in the stomachs included perch (2%), sculpins (18%), unidentified fish (22%), mayfly nymphs (29%), other aquatic insects (8%), unidentified insects (<1%), plant material (1%), worms (6%), and unknown larval fish (<1%). Of all of the smallmouth bass stomachs that contained food, 13% contained identifiable kokanee.

DISCUSSION

Adult kokanee in Coeur d'Alene Lake have remained a declining population since the flood year of 1997. Since that year, most generations of kokanee have failed to replace themselves. The same held true this year when 202,400 age-3 kokanee in 2004 produced only 28,000 age-3 kokanee in 2008. A stock-recruitment curve for this population was below the line of equal replacement indicating a population headed toward further decline (Figure 21). Recent efforts to restore kokanee included stopping the stocking of Chinook salmon during 2007 and 2008, disturbing or destroying Chinook salmon redds in the Coeur d'Alene River drainage, and closing the kokanee fishery in the fall of 2006, 2007 and 2008. These efforts appear to be working. Abundance of age-1 and age-2 kokanee were the highest since before the 1997 flood. If survival remains good for one more year, then adult kokanee abundance should be restored. We therefore recommend resuming Chinook salmon stocking at a limited level in 2009, and carefully monitoring the response of the kokanee population.

Rieman and Meyers (1990) suggested kokanee became exponentially more vulnerable to anglers with increases in size. They further hypothesized that exploitation may increase dramatically in populations with densities of age-3 fish less than 10 to 20 per ha and could result in the collapse of the fishery. Our July trawling results indicated a density of age-3 kokanee at 3 fish/ha and a mean size in the trawl catch of 270 mm (n=4). These adults could be highly vulnerable to anglers during fall since they concentrate in Wolf Lodge Bay for spawning. We therefore closed the kokanee fishery on September 2, 2008 (the day after the Labor Day holiday) to protect staging and spawning kokanee.

We found that smallmouth bass ate kokanee as a significant part of their diet (12%) during the late spring and early summer in Coeur d'Alene Lake. These kokanee were thought to be ages 1 and 2 based on their size (63 to 133 mm estimated total length). Our sampling was conducted at a time when kokanee fry should have been emerging, but no kokanee fry were identified in the stomachs. Some unidentified fry were found, but were not numerous (0.6% of the diet). Determining the number of kokanee eaten by the smallmouth bass population would require an estimate of smallmouth bass abundance, their growth rate, and the percent of kokanee in the diet during each season of the year. A simpler way to look at the current impact of smallmouth bass was to examine the survival rates of kokanee. Based on trawling, survival from age 0 to 1 and age 1 to 2 was 100% and 74%, respectively. These were considered high survival rates for kokanee based on trawling, and do not indicate a negative impact from predation from any source at this time. Low abundance of adult kokanee was therefore not attributed to smallmouth bass. Smallmouth bass appeared to be expanding in the lake, so their impact may be greater in the future.

By far the highest densities of kokanee fry were found in Wolf Lodge Bay where they exceeded 14,000 fry/ha (Figure 18). We therefore recommend stocking Chinook salmon in this bay, or in Wolf Lodge Creek that drains into the bay, so that age-0 Chinook salmon will have a readily available food supply that may improve Chinook salmon survival. This would also provide a fall fishery at the north end of the lake when adult Chinook salmon return to spawn.

Little confidence can be placed in the Chinook salmon population estimate of 1,300 fish >590 mm/ha since it was based on one fish being recorded in the hydroacoustic survey. The hydroacoustic estimate does illustrate a common problem in surveying for fish of very low abundance – low sample size. We pinged only one fish large enough that it was likely a Chinook salmon while sampling 7.5 ha of area on all of the transects combined. Doubling sample size could be accomplished by multiplexing two transducers on the same survey, by doubling the number of transects, or by obtaining a transducer with a wider beam width. All three of these measures should be investigated to help boost sample sizes if Chinook salmon surveys are conducted in the future.

Another possible way to increase sample size would be to conduct the survey when Chinook salmon are deeper in the water column. If Chinook salmon were on average twice as deep, then the diameter of the beam would also double and twice as many fish would be sampled. This was the intent of our December 3, 2008 survey. Although a few single fish were located near kokanee schools, none of them were over -30 dB, a size too large to be kokanee. Knowing the seasonal depth distribution of Chinook salmon would help in identifying Chinook salmon and choosing the best season to conduct hydroacoustic surveys. We therefore recommend tracking sonic tagged salmon to acquire habitat-use data to guide future surveys.

MANAGEMENT RECOMMENDATIONS

1. Resume limited Chinook salmon stocking (10,000 fingerlings) in the spring of 2009. If the kokanee population appears to have recovered during the July kokanee monitoring, then stock an additional 10,000 fingerlings during the fall to restore the Chinook salmon fishery and to keep kokanee within the desired density range of 30-50 age-3 kokanee/ha.

2. Compare the spring and fall stockings of Chinook salmon to evaluate which stocking strategy provides the best survival.

3. Stock Chinook salmon fingerlings into Wolf Lodge Bay, or Wolf Lodge Creek, in order place them near the highest density of kokanee forage.

4. Continue to keep wild spawning Chinook salmon in check in the Coeur d'Alene and St. Joe drainages by limiting the number of redds to 100.

5. Evaluate the potential use of sterile Chinook salmon for stocking in Coeur d'Alene Lake. This would provide tighter control of the Chinook salmon population by reducing the risk of stocked fish spawning in the wild.

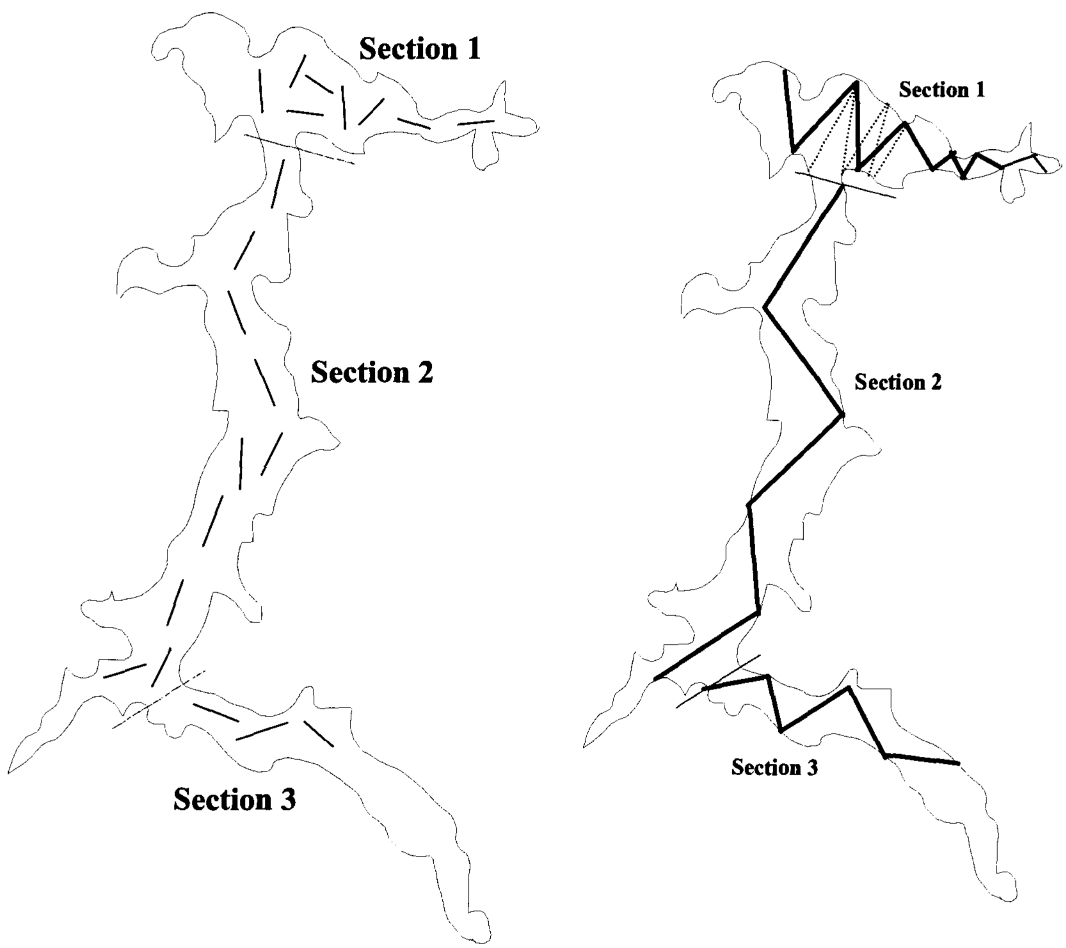


Figure 14. Location of 21 midwater trawling transects (left), and 21 hydroacoustic transects (right), in three sections of Coeur d'Alene Lake, Idaho, used to estimate kokanee population abundance in 2008. Finely dotted lines in Section 1 of right-hand map indicate hydroacoustic transects used during a survey for Chinook salmon.

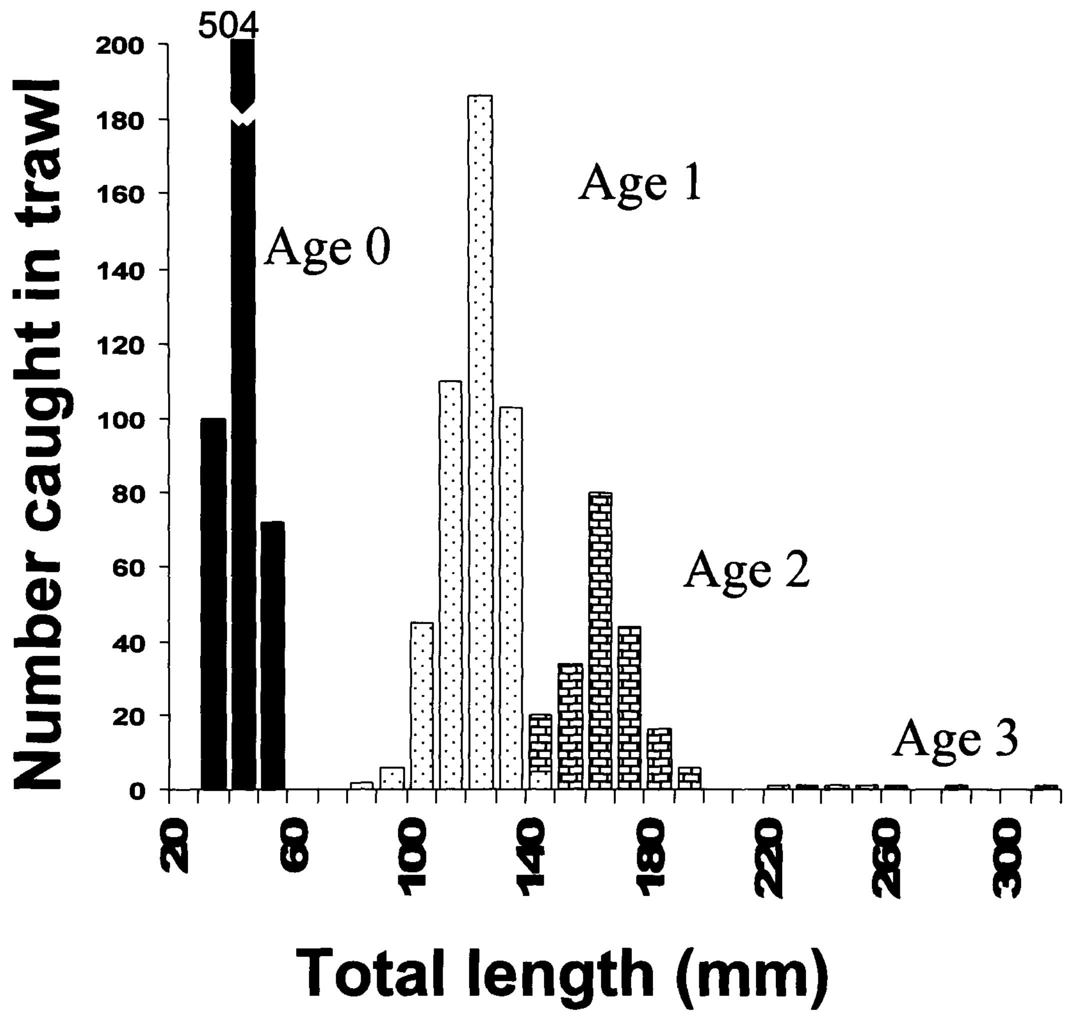


Figure 15. Length-frequency distribution of kokanee sampled in Coeur d'Alene Lake while trawling during 2008.

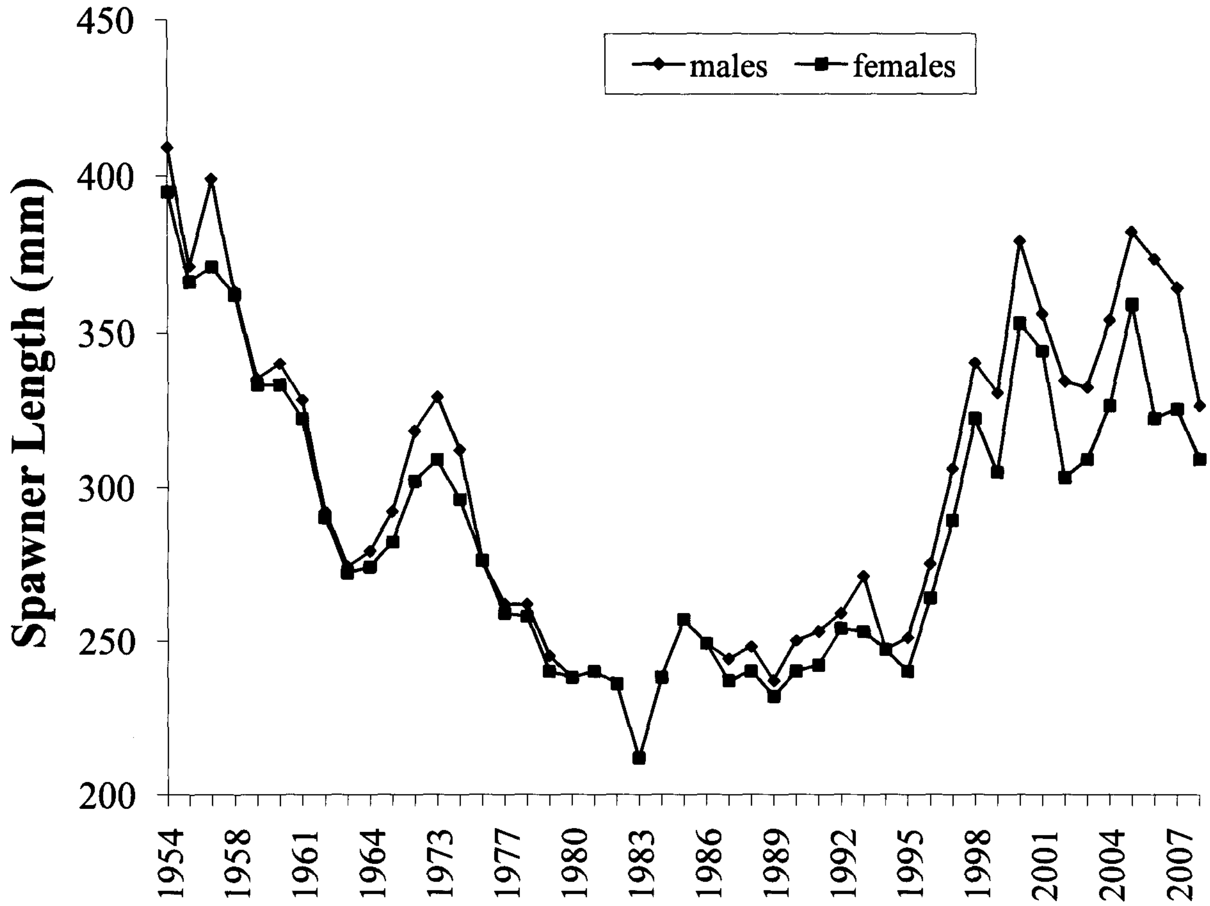


Figure 16. Mean total length of male and female kokanee spawners in Coeur d'Alene Lake, Idaho, from 1954 to 2008. Years where mean lengths were identical between sexes were a result of averaging male and female lengths together.

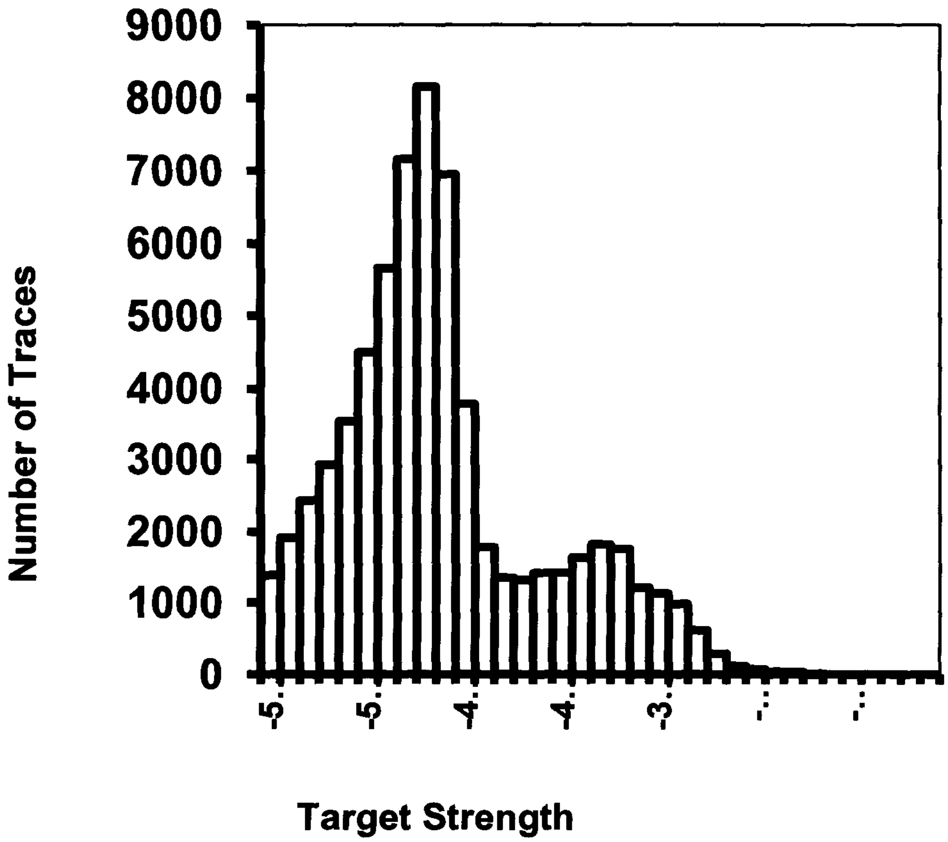
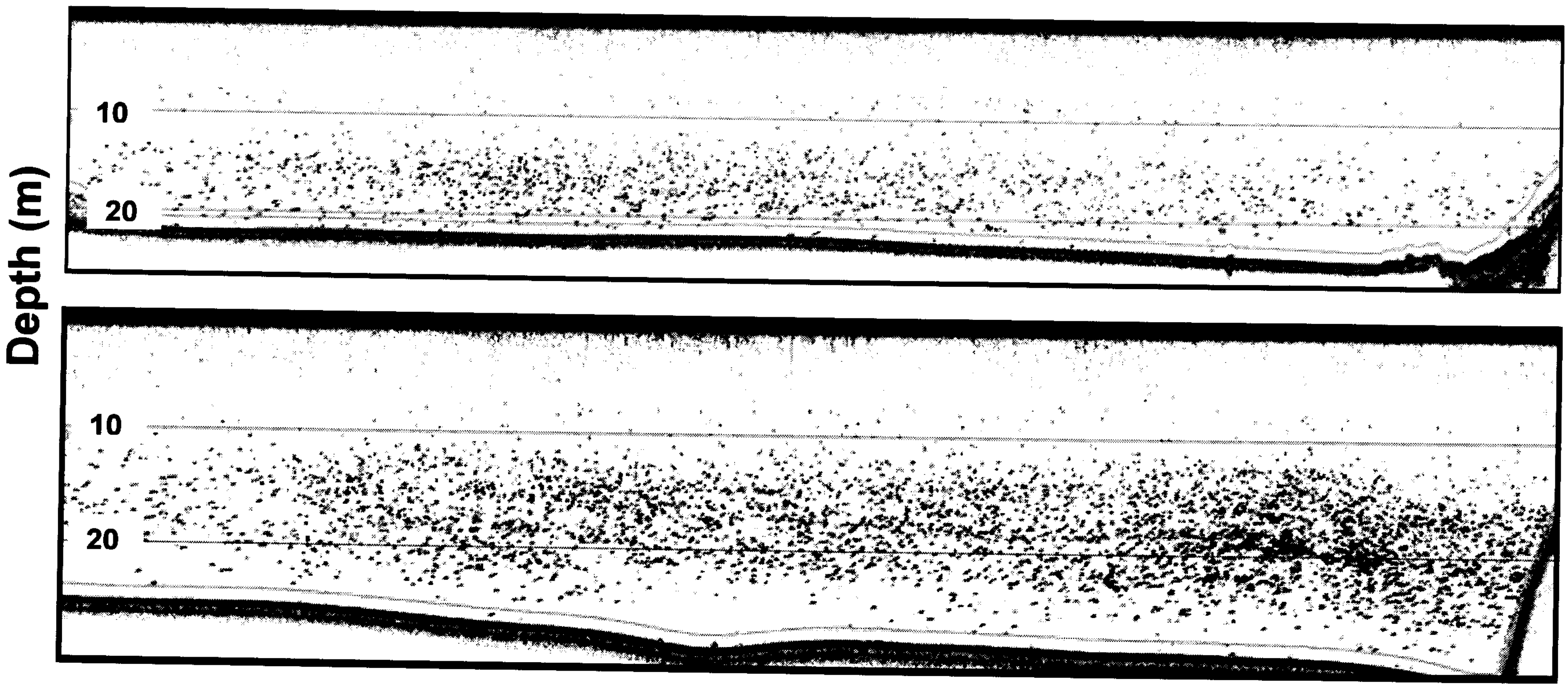


Figure 17. Target strength-frequency distribution of fish within the kokanee layer sampled while conducting hydroacoustic surveys on Coeur d'Alene Lake 2008.

Figure 18. Echograms of the two eastern-most transects in Wolf Lodge Bay on Coeur d'Alene Lake during the night of August 5, 2008. Top transect had a density of 5,600 fry/ha and lower transect had a density of 14,800 fry/ha. Green line over the bottom was used to exclude all targets below this depth.



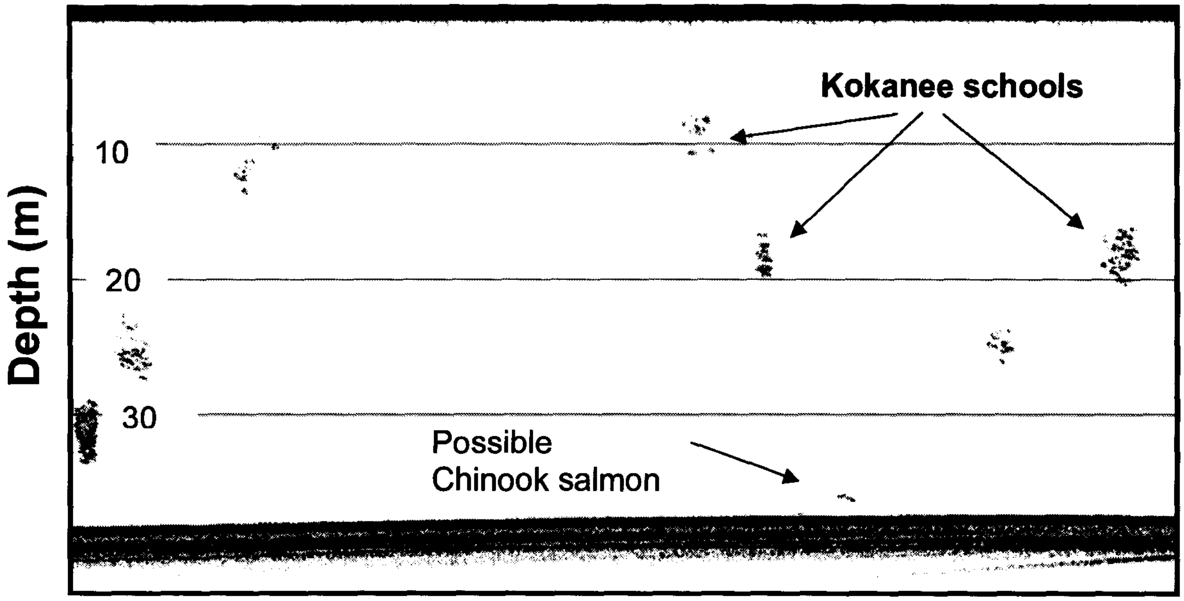


Figure 19. Section of an echogram from the north end of Coeur d'Alene Lake recorded on December 3, 2008. Single fish on the bottom labeled as "possible Chinook salmon" had an estimated length of 380 mm.

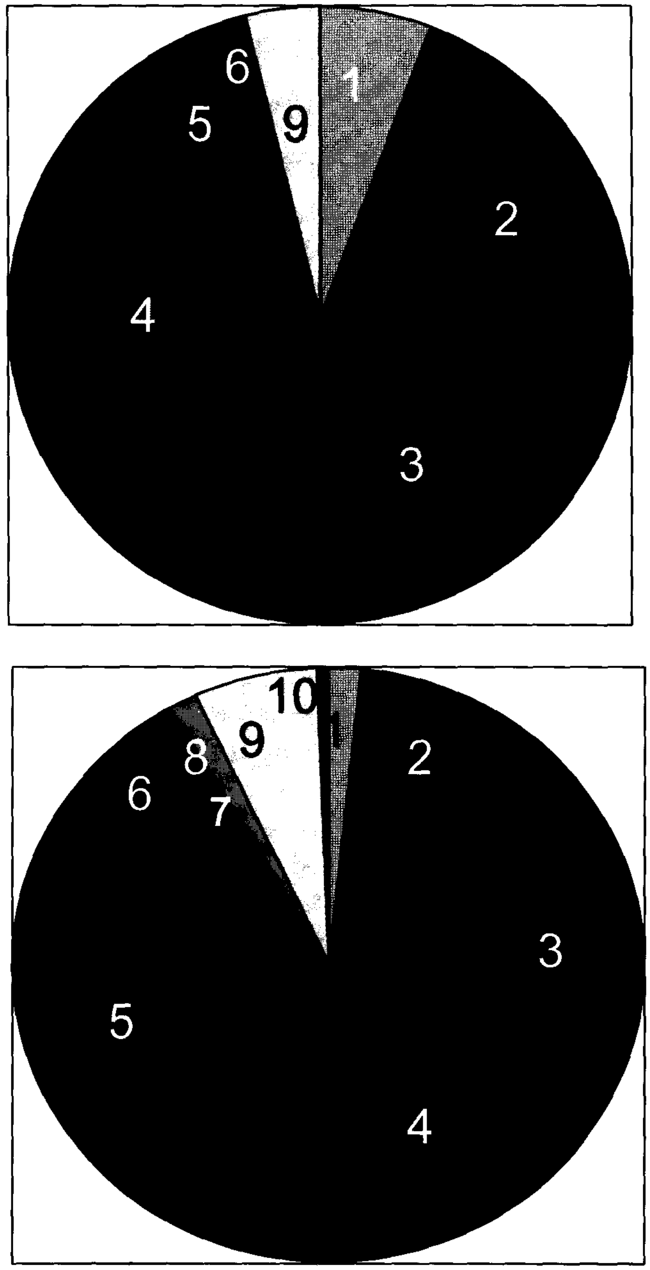


Figure 20. Items found in the stomachs of smallmouth bass sampled in Coeur d'Alene Lake during June 2008. Top: the percent weight of all items in all fish stomachs combined. Bottom: the percentage of items in individual stomachs averaged for 60 individuals. 1= perch, 2= kokanee, 3=sculpins, 4= unknown fish, 5=mayflies, 6= aquatic insects, 7= unknown insects, 8= plant material, 9= worms, and 10= larval fish.

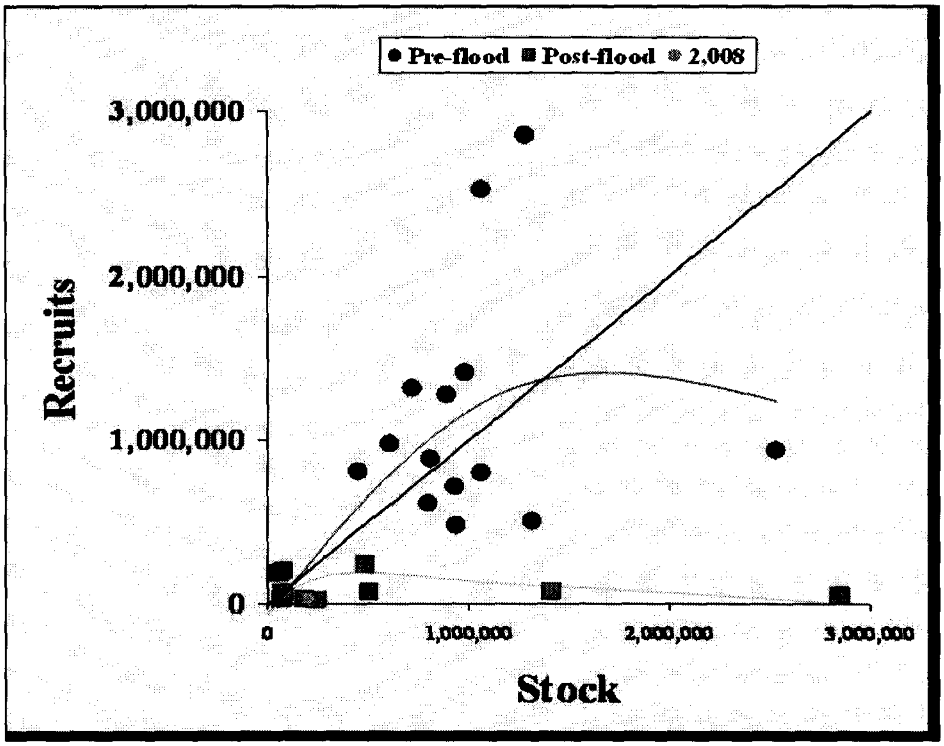


Figure 21. Stock-recruitment curve for Coeur d'Alene Lake kokanee. Figure was based on age 3 kokanee to age 3 kokanee four years later. Pre-flood data included data before 1997, post-flood data was for 1997 to 2008. Dot nearest the origin is for 2008.

Table 5. Estimated abundance of kokanee made by midwater trawl in Coeur d'Alene Lake, Idaho, from 1979-2007. To follow a particular year class of kokanee, read right one column and up one row.

Sampling	Age Class				Total	Age
Year	Age 0+	Age 1+	Age 2+	Age 3/4+		3+/ha
2008	3,035,000	3,610,000	1,755,000	28,000	8,428,000	3
2007	3,603,000	2,367,000	136,000	34,000	6,140,000	3
2006	7,343,000	1,532,000	91,000	33,900	8,999,000	3
2005	-	-	-	-	-	-
2004	7,379,000	1,064,000	141,500	202,400	8,787,000	21
2003	3,300,000	971,000	501,400	182,300	4,955,000	19
2002	3,507,000	934,000	695,200	70,800	5,207,000	7
2001	7,098,700	929,900	193,100	25,300	8,247,000	3
2000	4,184,800	783,700	168,700	75,300	5,212,600	8
1999	4,091,500	973,700	269,800	55,100	5,390,100	6
1998	3,625,000	355,000	87,000	78,000	4,145,000	8
1997	3,001,100	342,500	97,000	242,300	3,682,000	25
1996	4,019,600	30,300	342,400	1,414,100	5,806,400	146
1995	2,000,000	620,000	2,900,000	2,850,000	8,370,000	295
1994	5,950,000	5,400,000	4,900,000	500,000	12,600,000	51
1993	5,570,000	5,230,000	1,420,000	480,000	12,700,000	50
1992	3,020,000	810,000	510,000	980,000	5,320,000	102
1991	4,860,000	540,000	1,820,000	1,280,000	8,500,000	133
1990	3,000,000	590,000	2,480,000	1,320,000	7,390,000	137
1989	3,040,000	750,000	3,950,000	940,000	8,680,000	98
1988	3,420,000	3,060,000	2,810,000	610,000	10,900,000	63
1987	6,880,000	2,380,000	2,920,000	890,000	13,070,000	93
1986	2,170,000	2,590,000	1,830,000	720,000	7,310,000	75
1985	4,130,000	860,000	1,860,000	2,530,000	9,370,000	263
1984	700,000	1,170,000	1,890,000	800,000	4,560,000	83
1983	1,510,000	1,910,000	2,250,000	810,000	6,480,000	84
1982	4,530,000	2,360,000	1,380,000	930,000	9,200,000	97
1981	2,430,000	1,750,000	1,710,000	1,060,000	6,940,000	110
1980	1,860,000	1,680,000	1,950,000	1,060,000	6,500,000	110
1979	1,500,000	2,290,000	1,790,000	450,000	6,040,000	46
Mean abundance from 1979-2006	**3,856,285**	**1,552,078**	**1,516,930**	**762,574**	**7,568,930**	**79**

Table 6. Kokanee population estimates and standing crop (kg/ha) in each section of Coeur d'Alene Lake, Idaho, July 28-30, 2008 based on trawl sampling.

Section	Age 0	Age 1	Age 2	Age 3	Kg/ha
1	2,857,601	428,989	34,121	8,606	5.11
2	160,824	1,460,526	955,180	19,098	10.55
3	16,781	1,720,932	765,608	0	32.33
Whole lake total	3,035,206	3,610,447	1,754,909	27,704	13.29
90% confidence limits as a percent	120%	24%	52%	89%	

Table 7. Estimates of female kokanee spawning escapement, potential egg deposition, fall abundance of kokanee fry, and their subsequent survival rates in Coeur d'Alene Lake, Idaho, 1979-2007.

Year	Estimated female escapement	Estimated potential number of eggs ($x10^6$)	Fry estimate the following year ($x10^6$)	Percent egg to fry survival
2008	13,852	10		
2007	17,100	13	3.04	23.4
2006	16,900	12	3.60	28.9
2005	-[a]	-[a]	7.34	-[a]
2004	101,000	76	-[a]	-[a]
2003	91,000	62	7.38	12.0
2002	35,000	25	3.30	13.2
2001	12,650	10	3.50	34.0
2000	37,700	32	7.10	22.2
1999	28,000	19	4.18	22.6
1998	39,000	26	4.09	15.7
1997	90,900	54	3.60	6.67
1996	707,000	358	3.00	0.84
1995	1,425,000	446	4.02	0.90
1994	250,000	64	2.00	0.31
1993	240,000	92	5.95	6.46
1992	488,438	198	5.57	2.81
1991	631,500	167	3.03	1.81
1990	657,777	204	4.86	1.96
1989	516,845	155	3.00	1.94
1988	362,000	119	3.04	2.55
1987	377,746	126	3.42	2.71
1986	368,633	103	6.89	6.68
1985	530,631	167	2.17	1.29
1984	316,829	106	4.13	3.90
1983	441,376	99	0.70	0.71
1982	358,200	120	1.51	1.25
1981	550,000	184	4.54	2.46
1980	501,492	168	2.43	1.45
1979	256,716	86	1.86	2.20

[a] No estimate could be made due to missing trawl data in 2005.

Table 8. Kokanee population estimates and standing stock (kg/ha) in each section of Coeur d'Alene Lake, Idaho, August 5-7, 2008 based on hydroacoustic and trawl sampling. NASC is the nautical area scattering coefficient in m^2/nautical $mile^2$.

Section	Age 0	Age 1	Age 2	Age 3	Standing Stock (kg/ha)	NASC
1	8,206,000	757,000	60,000	15,000	10.3	246.0
2	1,542,000	798,000	522,000	11,000	6.1	96.9
3	529,000	578,000	257,000	0	10.8	196.26
Whole lake total	10,277,000	2,133,000	839,000	26,000		
Area weighted mean					7.9	147.9

Table 9. Chinook salmon redd counts in the Coeur d'Alene (Cd'A) River drainage, St. Joe River and Wolf Lodge Creek, Idaho, 1990-2008.

	Coeur d'Alene River								St. Joe River					Wolf Lodge Creek	
Date	Catalaldo Mission to S.F. Cd'A River	South Fork Cd'A to L.N.F. Cd'A River	L.N.F. Cd'A to Steamboat Creek	Steamboat Creek to Steel Bridge	Steel Bridge to Beaver Creek	South Fork Cd'A River	Little North Fork Cd'A River	**Coeur d'Alene River Subtotal**	St. Joe City to Calder	Calder to Huckleberry Campground	Huckleberry Campground to Marble Creek	Marble Creek to Avery	**St. Joe River Subtotal**	Wolf Lodge Creek	**Total**
1990	41	10	-	-	-	-	-	51	4	3	3	0	10	--	61
1991	11	0	2	-	-	-	-	13	0	1	0	0	1	-	14
1992	29	5	3	1	-	-	-	38	18	1	2	0	21	-	59
1993	80	11	6	0	-	-	-	97	20	4	0	0	24	-	121
1994	82	14	1	0	0	13	0	110	6	0	1	1	8	-	118
1995	45	14	1	2	0	-	2	64	1	0	0	0	1	-	65
1996	54	13	13	0	0	4	0	84	59	5	7	0	71	-	155
1997	18	5	6	3	1	0	0	33	20	2	2	0	24	-	57
1998	11	3	1	0	0	0	0	15	3	1	0	2	6	4	25
1999	7	5	0	0	0	0	0	12	0	0	0	0	0	5	17
2000	16	20	3	0	0	5	1	45	5	0	0	0	5	3	53
2001	18	13	2	1	0	4	0	38	21	15	-	-	36	4	78
2002	14	10	6	0	0	3	0	33	14	4	0	0	18	0	51
2003	27	17	2	0	0	5	0	51	15	9	3	0	27	0	78
2004	24	36	4	2	0	4	1	71	15	3	0	0	18	1	90
2005	30	7	3	0	0	8	1	49	7	3	0	0	10	1	60
2006	30	80	14	7	0	10	0	141	15	1	0	0	16	-	157
2007	63	20	4	1	0	13	0	101	23	4	0	0	26	-	127
2008	79	6	1	2	0	4	0	92	13	3	1	0	17	-	109

Table 10. Number of Chinook salmon stocked and estimated number of naturally produced Chinook salmon entering Coeur d'Alene Lake, Idaho, 1982-2007. The number of Chinook salmon redds is the count from the previous fall.

Year	Hatchery Produced				Naturally Produced		
	Number	Stock	Rearing Hatchery	Fin Clip	Previous year redd counts	Estimated Smolts	Total
1982	34,400	Bonneville	Hagerman	--	--	--	34,400
1983	60,100	Bonneville	Mackay	--	--	--	60,100
1984	10,500	L. Michigan	Mackay	--	--	--	10,500
1985	18,300	L. Michigan	Mackay	Left Ventral	--	--	18,300
1986	30,000	L. Michigan	Mackay	Right Ventral	--	--	30,000
1987	59,400	L. Michigan	Mackay	Adipose	--	--	59,400
1988	44,600	Coeur d'Alene	Mackay	Left Ventral	--	--	44,600
1989	35,400	Coeur d'Alene	Mackay	Right Ventral	--	--	35,400
1990	36,400	Coeur d'Alene	Mackay	Adipose	52	20,800	57,200
1991	42,600	Coeur d'Alene	Mackay	Left Ventral	70	28,000	70,600
1992	10,000	Coeur d'Alene	Mackay	Right Ventral	14	5,600	15,600
1993	0	--	--	--	63	25,200	25,200
1994	17,300	Coeur d'Alene	Nampa	Adipose	100	40,000	57,300
1995	30,200	Coeur d'Alene	Nampa	Left Ventral	100	40,000	70,200
1996	39,700	Coeur d'Alene	Nampa	Right Ventral	65	26,000	65,700
1997	12,600	Coeur d'Alene	Nampa	Adipose	84	33,600	46,200
1998	52,300	Priest Rapids	Cabinet G.	Left Ventral	57	22,800	75,100
1999	25,500	Big Springs	Cabinet G.	Right Ventral	25	10,000	35,500
2000	28,000	Big Springs	Nampa	Adipose	17	6,800	34,800
2001	0	--	--	--	53	21,200	21,200
2002	41,000	Big Springs	Nampa	Left Ventral	78	31,200	72,200
2003	44,800	Big Springs	Nampa	Right Ventral	51	20,400	65,200
2004	46,000	Big Springs	Nampa	Adipose	78	31,000	77,000
2005	26,300	L. Sacajawea	Nampa	Left Ventral	90	36,000	62,300
2006	47,600	L. Sacajawea	Nampa	Right Ventral	59	23,600	71,200
2007	0				100	40,000	40,000
2008	0				65	26,000	26,000

2008 Panhandle Region Fishery Management Report

LOWLAND LAKE SURVEYS

ABSTRACT

Lowland lake surveys were conducted on Cocolalla, Chase, Kelso, Black, and Killarney Lakes in 2008. Surveys were conducted to evaluate the effectiveness of stocking efforts, particularly of channel catfish in Cocolalla Lake, as well as bluegill and rainbow trout in Kelso Lake.

In Cocolalla Lake, channel catfish are well established with above average condition in all size classes. Fifty-six channel catfish ranging from 185 - 510 mm were captured, comprised 5% of the total catch by number and 11% of the total catch by biomass. Bluegill constituted 35% of the total catch and 18% of the total biomass in Kelso Lake. Few rainbow trout were captured in Kelso Lake and individuals largely represented one year class.

Black Lake was last surveyed in 1995 and at that time no bluegill or smallmouth were collected. During our 2008 lake survey bluegill was the third most abundant fish species in our sample, comprising 11% of the total catch. Smallmouth bass made up 6% of the sample by number and PSD was estimated at 21% with no fish in the preferred range (350 mm).

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INTRODUCTION

We assessed the fish populations in various lowland lakes in the Panhandle Region to determine the effects of various management actions. Our objective is to provide a diversity of angling opportunities for area anglers.

STUDY AREAS

Cocolalla Lake

Cocolalla Lake is located in Bonner County 12 km south of Sagle, Idaho (Figure 22). The lake has a surface area of 326 ha and is relatively shallow with a mean depth of 8 m. Boat access is available via an IDFG maintained ramp on the north end. Approximately 40% of the shoreline is developed with year-round and seasonal residences and 72% of the land in the Cocolalla Lake watershed is under private ownership. The entire eastern shoreline is owned by Burlington Northern Santa Fe Railway Company and was recently posted as "No Trespassing" which may have an impact on angler access. The department is currently seeking to resolve this issue.

The Cocolalla Lake watershed consists of 142 square km, 52 times greater than the 36 ha lake. Five major tributaries flow into Cocolalla Lake and intensive agriculture activities upstream play an important role relative to lake water quality. Phosphorus entering the lake from animal waste, septic systems, logging, and unpaved roads was identified as the main problem resulting in advanced eutrophication (Rothrock 1995). During late summer dissolved oxygen levels drop to near zero at depths greater than 6 m. In addition, lake temperatures often exceed 21°C to a depth of nearly 6 m, limiting the amount of usable habitat for trout.

The lake supports a diverse warmwater fishery as well as hatchery supported trout and channel catfish fisheries. In a 1992 creel survey hatchery rainbow trout were the major target of anglers comprising 45% of the effort (Davis et al. 1992). Channel catfish were introduced in 1985 and in the 1992 creel survey comprised 30% of the fishing effort. The intent of the catfish introduction was to utilize the abundant perch and pumpkinseed forage base. Seven to nine thousand catchable size catfish and approximately 30,000 triploid Kamloops rainbow trout fingerlings are stocked in Cocolalla Lake each summer. As reported in the 1992 creel survey, the warmwater fishery appears to be under-utilized, however, Cocolalla Lake does support a popular ice fishery for yellow perch. No largemouth bass or black crappie were reported in the creel, whereas in our recent lake survey we captured crappie as large as 256 mm and largemouth bass as large as 461 mm, both of which are in the preferred range. Cocolalla Lake is managed under general fishing regulations.

Chase Lake

Chase Lake is located 1.7 km southeast of Coolin, Idaho in Bonner County (Figure 23). The lake is shallow with a mean depth of 2.5 m and has a surface area of approximately 56 ha.

The outlet is an ephemeral stream during drought years, flowing about 2 km into Priest Lake at Coolin Bay.

Chase Lake is managed to provide a quality largemouth bass fishery and current regulations limit anglers to 2 largemouth bass with none under 16 inches (406 mm). These regulations have been in effect since 2008, however, since the late '80's Chase Lake largemouth bass between 12-16 inches (305 – 406 mm) were protected. Chase Lake is currently managed as "electric motors only". Chase Lake has never been stocked by IDFG. Surveys and officer creel reports from the early 1970s indicated that only largemouth bass and pumpkinseed were present. A survey conducted in 1984 indicated the presence of yellow perch and brown bullhead in addition to largemouth bass and pumpkinseed. A 1994 survey revealed the same fish community structure as in 1984 (Davis et al. 1994). Angler reports indicate catches of large yellow perch and pumpkinseed from Chase Lake. Our 2008 lake survey confirmed perch as large as 313 mm in length and pumpkinseed as large as 221 mm. The state record pumpkinseed was caught in Chase Lake in 1977 at 14 oz.

Occasionally anglers report "wormy" yellow perch and pumpkinseeds in Chase Lake. Yellow grub *Clinostomum marginatum* and black spot or black grub *Uvulifer ambloplitis* are two common North American fish parasites found in Chase Lake. Anglers are advised that with proper preparation these parasites offer no health concern to humans.

Kelso Lake

Kelso Lake is a 24.8 ha lake located in Bonner County, 7 km north of Athol, Idaho (Figure 24). The lake is connected to nearby Little Round and Granite Lakes by a low gradient wetland area. Kelso Lake has an average depth of 7.6 m.

Kelso Lake is currently managed as a family fishing water, (year round season, limit of 6 trout and 6 bass, and no length limits) and is an "electric motors only" waterbody. Five to ten thousand triploid rainbow trout are stocked annually as catchables in Kelso Lake.

Kelso Lake was treated with Rotenone and Fintrol in 1968 to remove undesirable species and by 1973 the species composition was identical to pre-treatment. In 1982, 400 bluegill from the Bruneau Sand Dunes Lake in southern Idaho were transplanted into Kelso Lake in hopes of establishing a future source for bluegill in the Panhandle Region. The largemouth bass population was established in 1984 when 100 adult bass were released.

Black Lake

Black Lake is located 9 km east of Harrison, Idaho in Kootenai County (Figure 25) and is one of a series of lateral lakes connected to the Coeur d'Alene River by a channel. There are no public boat ramps on Black Lake; however, the lake is easily accessible by way of Medicine Lake approximately 5 km up the Coeur d'Alene River. The lake has a mean depth of 5 m and a surface area of 152 ha.

Typical of the Coeur d'Alene lateral lakes, Black Lake supports a diverse warmwater fishery, including bluegill, black crappie, largemouth bass, smallmouth bass and northern pike. Other game species present include yellow perch, pumpkinseed, and brown bullhead. Stocking records indicate no stocking history and Black Lake is managed under general fishing regulations for all species.

Killarney Lake

Killarney Lake is a 202 ha lake located in Kootenai County approximately 17 km southeast of Coeur d'Alene, Idaho. The lake is one of a series of lateral lakes connected to the Coeur d'Alene River. At summer elevation (648.6 m), maximum depth of Killarney Lake is around 4.5 m, and mean depth is approximately 2.5 m. The Bureau of Land Management (BLM) maintains a boat ramp and campground on the southeastern shore. The lake is also accessible by boat through an approximately 0.5 km channel from the Coeur d'Alene River. There are several boat camping sites around the lake, including a developed area on Popcorn Island. The majority of shoreline angling takes place at the campground and boat launch area.

Approximately half of the shoreline is federally owned, with the other half being privately owned. Much of the Killarney Lake shoreline is steep and comprised of timber and bedrock. The remaining shoreline, mainly along the bays, is shallow with a broad littoral zone marked by dense submersed, floating and emergent macrophytes. Stocking records indicate no stocking history and Killarney Lake is managed under general fishing regulations for all species. Gill nets and trap nets were set on July 2, 2008; however, we were unable to electrofish Killarney Lake due to electrical storms (Figure 26).

METHODS

We conducted lowland lake surveys in 2008 using procedures outlined in the IDFG Standard Lowland Lakes Survey Manual. We used two trap nets, two floating and two sinking gill nets set overnight, and one hour of electrofishing effort on each lake. Cocolalla Lake was electrofished and nets set the night of May 15. Chase Lake was netted and electrofished on the night of May 27. Kelso Lake was netted and electrofished on the night of June 18 and Black Lake was netted and electrofished on the night of July 1. We were unable to electrofish Killarney Lake due to electrical storms but nets were set on July 2.

We used a Smith-Root SR-16 electrofishing boat to assess fish populations. Electrofishing was conducted at night concentrating our efforts along the shoreline in an attempt to collect all species. Gill nets and trap nets were set perpendicular to shore, set at dusk and retrieved the following morning. After capture, fish were identified, weighed (g) and measured to the nearest mm.

Proportional stock density (PSD; Anderson 1980) was calculated to examine trends in regional fisheries and historic survey data. PSD was estimated as:

$$PSD= \frac{\text{number of fish} \geq \text{quality length}}{\text{number of fish} \geq \text{stock length}} \times 100$$

In addition, condition of fish was indexed using relative weight (Wr), represented by the equation:

$$Wr=(W/Ws) * 100$$

Where W is the weight of an individual fish and Ws is a length-specific standard weight resultant of a weight:length regression representative of the species:

$$\log_{10}(Ws) = a' + b * \log_{10}(L)$$

Where a′ is the intercept and b is the slope and L is the total length of the individual fish. Values were calculated by 10 mm length categories and missing values were estimated. Mean Wr values of 100 indicate ecological and physiological optimal body condition (Anderson and Neumann 1996, Blackwell et al. 2000).

Water quality parameters typically collected include temperature, dissolved oxygen (DO), pH, and conductivity. Measurements were made using a YSI meter. Water quality measures are collected during daytime hours. Zooplankton samples are collected from two locations distributed throughout the lake or reservoir. Zooplankton quality index (ZQI) is determined from collected samples as described by Teuscher (1999). ZQI is used to evaluate productivity in the given water body.

RESULTS

Cocolalla Lake

We found a diverse and abundant fish community in Cocolalla Lake through our sampling efforts. We captured 11 gamefish species (84% of the total catch) including bluegill (BG), rainbow trout (RBT), brown trout (BT), cutthroat trout (WCT), brook trout BRK), black crappie (BC), channel catfish (CC), pumpkinseed (PS), largemouth bass (LMB), yellow perch (YP), and brown bullhead (BBH) (Figure 27). Non-game species (16% of the total catch) included peamouth (PEA), longnose sucker (LNS) *C. catostomus*, and largescale sucker (LSS).

Yellow perch was the most abundant species by number (51%) (Figure 27), but only constituted 8% of the total catch by biomass (Figure 28). The average length within the catch was 182 mm with a range of 62 mm to 233 mm and an overall population PSD of 33 (Figure 29). Condition as indexed by relative weight, was good with an average Wr=85, however, relative weight decreased with increasing length (Figure 30).

Largemouth bass was the second most abundant species by number, comprising 11% of the total catch, and the second most abundant species by biomass, comprising 18% of the total biomass. The majority of largemouth bass present in Cocolalla Lake were < 250 mm in length (Figure 31). Very few largemouth bass were over 300 mm and represented a low PSD (PSD=6.4). Condition as indexed by Wr was below average with a mean score of 54. Wr was nearly identical for all size classes (Figure 32).

Fifty-six channel catfish were captured, comprised 5% of the total catch by number and 11% of the total catch by biomass. Their average total length was 291 mm with fish caught between 185-510 mm TL (Figure 33). PSD was estimated at 4.5. Condition as indexed by relative weight (Wr) was above average with a mean score of 105. Condition was consistently high among all size classes (Figure 34).

Trout species including brook trout, brown trout, rainbow trout, and cutthroat trout together constituted 3% of the total catch. Ten brown trout were collect ranging from 286 - 588 mm.

Chase Lake

Through our sampling efforts we found species abundance and diversity was low in Chase Lake. Species composition was identical to the 1994 (Davis et al. 1994) lake survey as gamefish species comprised 100% of the catch and included pumpkinseed, largemouth bass, yellow perch and brown bullhead (Figure 35).

Yellow perch was the most abundant species captured totaling 61% of the catch by number and 18% of the catch biomass. Yellow perch averaged 104 mm in length with a range of 43 - 313 mm (Figure 36) and an overall population PSD of 9.5. The range of lengths was similar to those reported from samples in 1994 (170 - 320) (Davis et al. 1994) (Table 11). Condition as indexed by Wr was above average with a mean score of 115. Wr decreased with increasing fish length (Figure 37).

Largemouth bass was the second most abundant species by number (19%), compared to 22% in 1994, and the most abundant by biomass (73%) (Table 11). The average length of largemouth bass captured was 359 mm, and lengths ranged from 219 - 417 mm (Figure 38). Proportional Stock Density was estimated at 95. Condition as indexed by Wr was 47 indicating less than average condition. Wr decreased slightly with increasing fish length (Figure 39)

Pumpkinseed comprised 18% of the total catch and 3% of the total biomass. Fish averaged 73 mm in length with a range of 32 - 221 mm.

Kelso Lake

Species including black crappie, bluegill, largemouth bass, pumpkinseed, rainbow trout, tench, and yellow perch were captured during sampling efforts on Kelso Lake. Species composition was nearly identical to the last time Kelso Lake was surveyed in 1984 (Horner and Rieman 1984). Gamefish species totaled 98% of the catch whereas the non-game species tench totaled 2% of the catch (Figure 40).

Bluegill was the most abundant species captured, constituting 35% of the total catch by number and 18% of the total catch by biomass (Figure 41). Their average total length was 141 mm with fish caught between 29 - 265 mm TL (Figure 42). PSD was estimated at 48. Bluegill condition as indexed by Wr was above average with a mean of 105. Wr remained constant among all fish lengths (Figure 43).

Largemouth bass was the second most abundant species by number (25%) and the most abundant species in terms of biomass (35%). Largemouth bass captured averaged 201 mm in length with a range of 61-559 mm (Figure 44). Condition as indexed by Wr was poor with an average of 56 (Figure 45). Wr was consistent for all fish lengths. Few largemouth bass were over 300 mm where captured and PSD was 22.

Few hatchery rainbow trout (n=14) were captured during sampling efforts and appeared to represent only two size classes. The average length of rainbow trout was 281 mm with a range of 247 - 392 mm.

Zooplankton abundance and size structure in Kelso Lake were described using the zooplankton quality index (ZQI) (Teuscher 1999). Teuscher calculated zooplankton biomass for seven Panhandle Region lakes in 1998 and reported a mean ZQI of 0.16. As expected, the North Idaho Lakes demonstrated lower overall zooplankton production than South Idaho Lakes. In 2008 Kelso Lake ZQI was 0.25 indicating competition for food may be occurring between yellow perch, bluegill and hatchery rainbow trout.

Black Lake

Gamefish species captured (93% of total catch) included kokanee, northern pike, black crappie, largemouth bass, smallmouth bass, pumpkinseed, bluegill, yellow perch, and brown bullhead as well as non-game (7% of total catch) largescale sucker, and tench (Figure 46).

Yellow perch was the most abundant fish species, comprising 54% of the total catch by number, and 23% of the total catch biomass (Figure 47). Yellow perch averaged 154 mm in length, ranging from a minimum of 30 mm to a maximum of 318 mm (Figure 48).

Bluegill was the third most abundant fish species, comprising 11% of the total catch, and 5% of the total biomass. Bluegill averaged 134 mm in length, with a range of 45 - 223 mm (Figure 49). Condition, as indexed by Wr, was above average at 118.

Pumpkinseed was the fourth most abundant fish species. Pumpkinseed made up 8% of the total catch by number and 2% of the total catch biomass. Fish averaged 97 mm, with a range of 39 mm to 270 mm.

We captured few largemouth bass (N=11), but the species comprised 8% of the biomass captured. Largemouth bass averaged 348 mm in length with a range of 92-540 mm. PSD was estimated at 70.

Smallmouth bass totaled 6% of the total catch by number and 4% of the total biomass. Total lengths ranged from 95 - 295 mm TL (Figure 50). The 1-year olds, 107 - 191 mm long, represented the major year class. PSD, where quality size is greater than or equal to 279 mm in length and stock size is greater than or equal to 178 mm was estimated at 21% with no fish in the preferred range (350 mm). Scale analysis indicate the smallmouth bass population in Black Lake took 3 years to reach quality size, 279 mm. Condition as indexed by Wr was good, with an average score of 102 (Figure 51).

Zooplankton production (ZQI) was 0.31 in Black Lake in 2008, well above the average 0.16 as reported by Teuscher in 1998.

Killarney Lake

As a result of our inability to conduct the electrofishing portion of the survey on Killarney Lake, the following results are likely not representative of the true fish community and no attempt was made to compare this survey to past surveys.

Gamefish species captured totaled 92% of the catch and included bluegill, largemouth bass, kokanee, yellow perch, black crappie, northern pike and brown bullhead. Non-game species totaled 8% of the catch and included tench, and northern pikeminnow (Figure 52). Northern pike was the second most abundant species by number (N=15), constituting 14% of the total catch, and was the most abundant species by biomass, constituting 49% of the catch (Figure 53).

Northern pike averaged 517 mm in length, ranging from a minimum of 394 mm to a maximum of 616 mm (Figure 54).

Ten black crappie were captured averaging 197 mm in length, ranging from a minimum of 144 mm to a maximum of 266 mm TL.

Two kokanee were captured during netting efforts and several more were found in the stomachs of northern pike and northern pikeminnow. Kokanee have not been reported in catches during previous surveys of Killarney Lake.

DISCUSSION

Cocolalla Lake

Cocolalla Lake was last surveyed in 1992 and species composition has changed little. In the 1992 survey, game fish comprised 93% of the sample compared to 84% in 2008 with yellow perch making up 57% of the catch in 1992 compared to 51% in 2008 (Davis et al. 1992). Largemouth bass made up 5% of the sample in 1992 compared to 11% in 2008. Channel catfish made up 10% of the sample in 1992 compared to 5% in 2008. Size structure of gamefish in Cocolalla Lake has changed little since 1992. Largemouth bass ranged from 100 - 450 mm in 1992 compared to 92 - 540 mm in 2008. Channel catfish ranged from 220 - 640 mm in 1992 and from 185 - 510 mm in 2008.

Only five hatchery rainbow trout and 10 hatchery cutthroat trout were collected in 2008. Cocolalla Lake was stocked with 20,000 cutthroat trout fingerlings and 27,000 triploid Kamloops rainbow trout fingerlings in 2007. Cocolalla Lake has potential low oxygen/high temperature limiting conditions for salmonids during late summer. The advanced state of eutrophication in Cocolalla Lake may be limiting the success of our salmonid stocking program. Additionally, Cocolalla Lake supports a diverse spiny-rayed fish population with yellow perch being the most abundant species. The yellow perch population does not appear to be controlled by largemouth bass or channel catfish as originally intended and may be limiting zooplankton abundance for salmonid species. Cocolalla Lake has good zooplankton production potential but evidence of fish cropping exists (Teuscher 1998). In a 1998 study which evaluated zooplankton communities in 40 Idaho lakes and reservoirs Cocolalla Lake ranked among the lowest ZQI at 0.03 indicating very low densities of usable zooplankton and virtually no preferred zooplankton prey.

Chase Lake

Species composition in Chase Lake has not changed over the past 25 years, however, at first glance it would appear that mean size of yellow perch and pumpkinseed is significantly less than previous surveys and conversely, largemouth bass mean length increased (Table 11).

This is probably the result of different sampling effort and/or gear type used in each survey. During the 2008 survey we used a combination of electrofishing, floating and sinking gill nets and trap nets. During the 1984 and 1994 surveys, no electrofishing was conducted. Additionally, during the 1984 survey only gill nets were used. Chase Lake is managed under trophy bass regulations (limit 2: none under 16 inches) and this regulation appears to be working as mean length of largemouth during our 2008 survey was 359 mm.

Kelso Lake

While species composition was nearly identical to the 1984 survey, there has been numerous changes relative to biomass in Kelso Lake (Horner and Rieman 1984). Bluegill was the most abundant species captured in 2008, constituting 35% of the total catch by number, compared to only 2% in 1984. In 1984, only one largemouth bass was captured compared to 156 largemouth bass in 2008. This constituted 26% of the catch by number and 35% by weight. During the 2008 survey, yellow perch constituted 13% of the total catch by number compare to 35% of the catch in 1984 (Table 11). Yellow perch size structure has improved, as in 1984 yellow perch averaged 163 mm compared to 237 mm in 2008.

Five-thousand triploid rainbow trout were stocked as catchables in Kelso Lake in 2007. During our 2008 survey, 14 rainbow trout ranging from 247 - 392 mm were collected indicating some potential for winter holdover. The continual demand for catchable trout along with tighter budgets highlights the need to maximize return to creel. Stocking rates can no longer be allocated on surface area alone but rather need to be linked to rate of return, effort, and availability of other species. During a 1987 evaluation, return to creel rates for Kelso Lake catchables was estimated at 63% (Horner et al. 1987). Evaluation of return to creel as well as the potential for winter hold-over and second year returns will be conducted in 2009 on several area lakes including Kelso Lake.

Anglers have reported worm like organisms attached to the gill area on hatchery rainbow trout caught in Kelso Lake during the late summer. The worm-like organisms (anchorworms) are the reproductive stage of *Lernaea cyprinacea,* a whitish copepod roughly 6 mm in length. Anchor worms are typically reported in midsummer each year and as water temperature cool the parasitic stage eventually drops away from the fish, becoming a free swimming "shrimp-like" adult.

Black Lake

Black Lake was last surveyed in 1995 and at that time no bluegill were reported in the sample. Bluegill was the third most abundant fish species in our sample, comprising 11% of the total catch, and 5% of the total biomass. Bluegill were first introduced into Rose Lake in 1990 and we suspect this is the source of Black Lake bluegill.

Largemouth bass averaged 348 mm in length with a range of 92 - 540 mm. PSD was estimated at 70, nearly identical to the 1995 lake survey when Black Lake largemouth bass PSD was reported to be 66% (Davis et al. 1994).

Smallmouth bass were illegally introduced in Lake Coeur d'Alene in the late 1980's. We suspect they were illegally transported from Hayden Lake where they were introduced by IDFG in 1983 to 1986. Lake surveys of adjacent Coeur d'Alene Lake Chain Lakes (Medicine, Cave, Killarney Lakes) in 1998 reported no smallmouth bass present at that time (Fredericks et al. 1998). In 2008, smallmouth bass totaled 6% of the total catch, additionally, the predominance of age 1-3 fish suggests the population is young and will expand. In 2009 Black Lake as well as most other Coeur d'Alene Lateral Lakes will be surveyed to evaluate changes in bass population structure, age and growth, and exploitation.

Killarney Lake

Unfortunately we were unable to electrofish Killarney Lake due to electrical storms; however, during the summer of 2009 we will sample Killarney Lake as part of the aforementioned bass study.

MANAGEMENT RECOMMENDATIONS

Conduct largemouth and smallmouth bass distribution, abundance, and life history characteristics study in the Coeur d'Alene Lateral Lakes system during 2009 and compare to previous years studies.

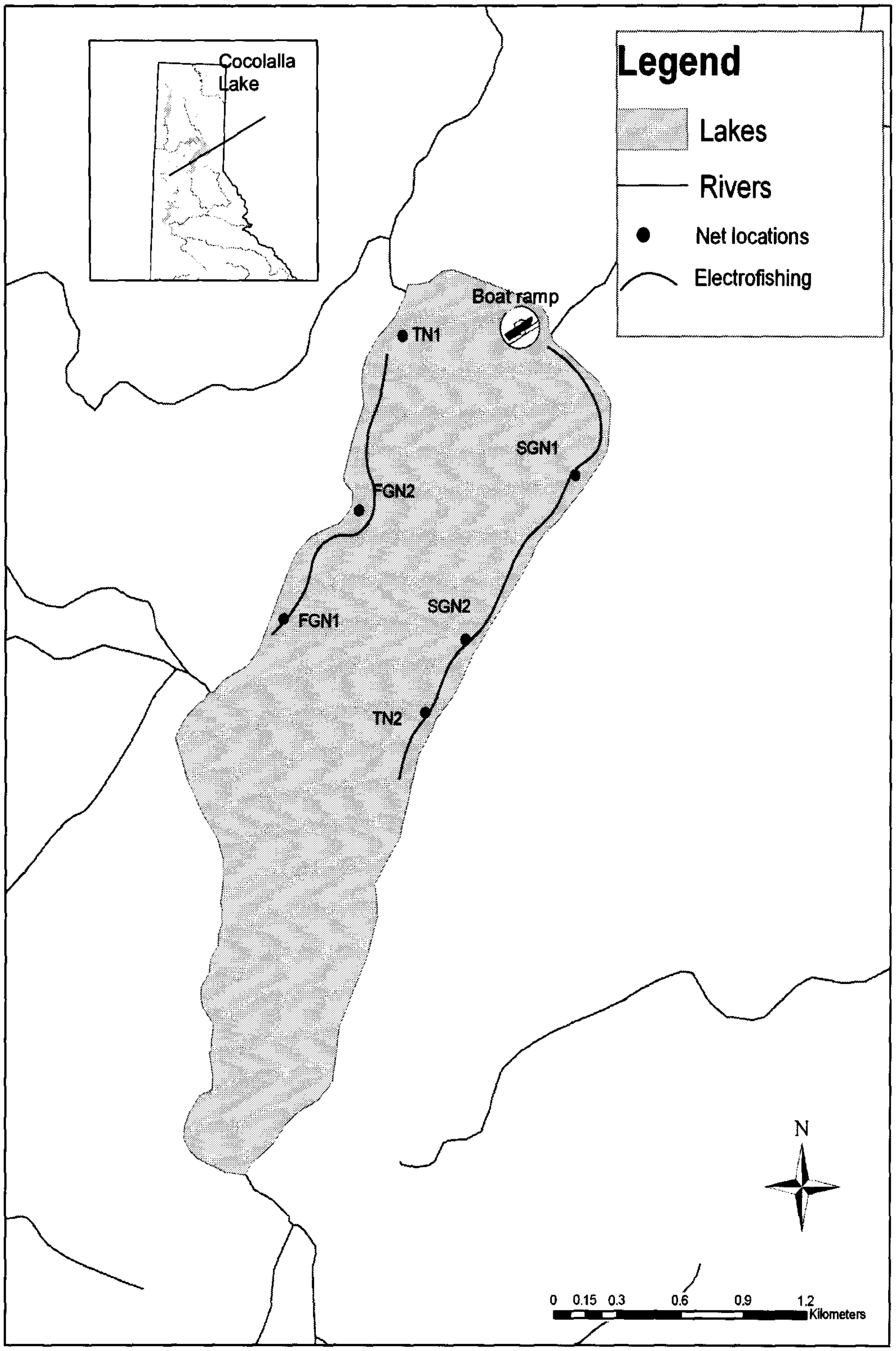


Figure 22. Locations of trap nets (TN1 and TN2), floating gill nets (FGN1 and FGN2), sinking gill nets (SGN1 and SGN2), and shoreline electrofishing during a lowland lake survey in May 2008, Cocolalla Lake, Idaho.

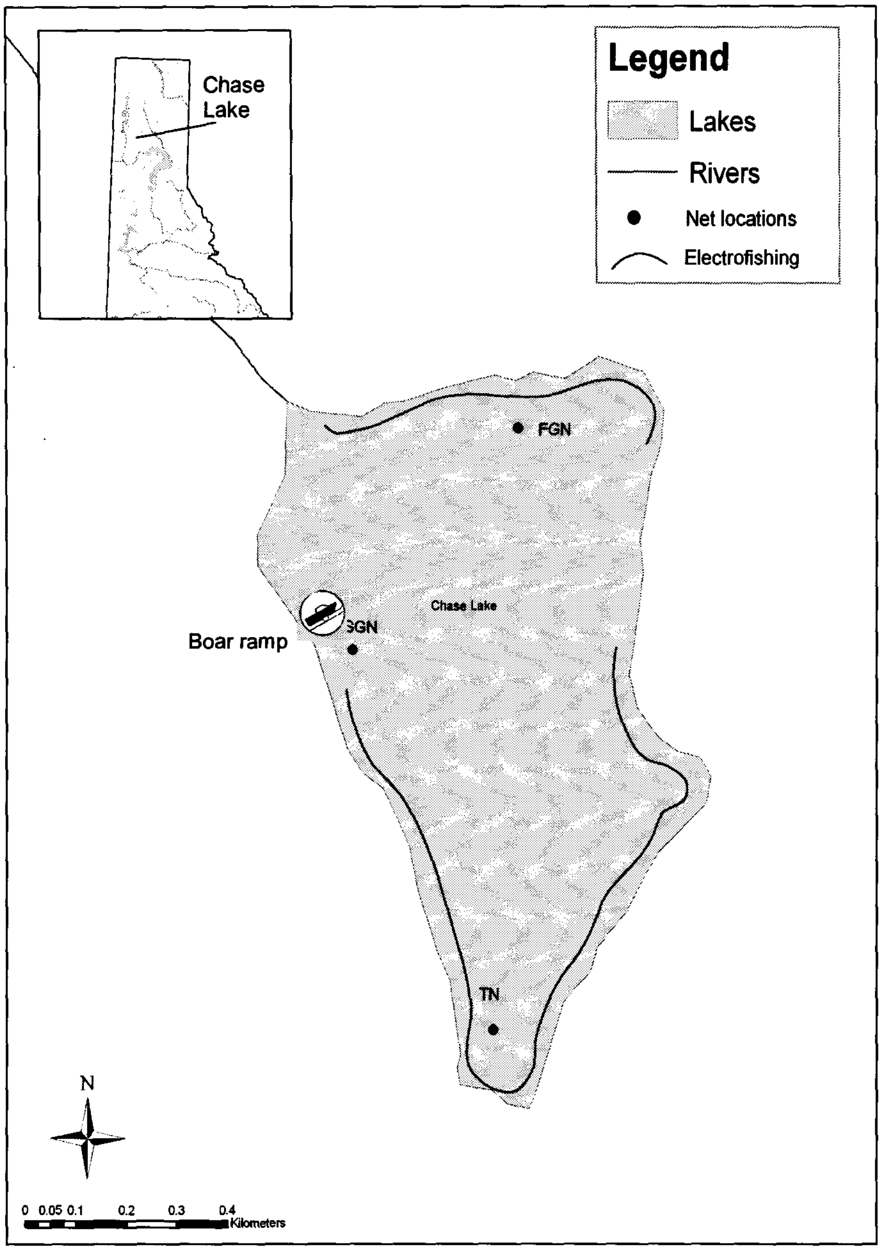
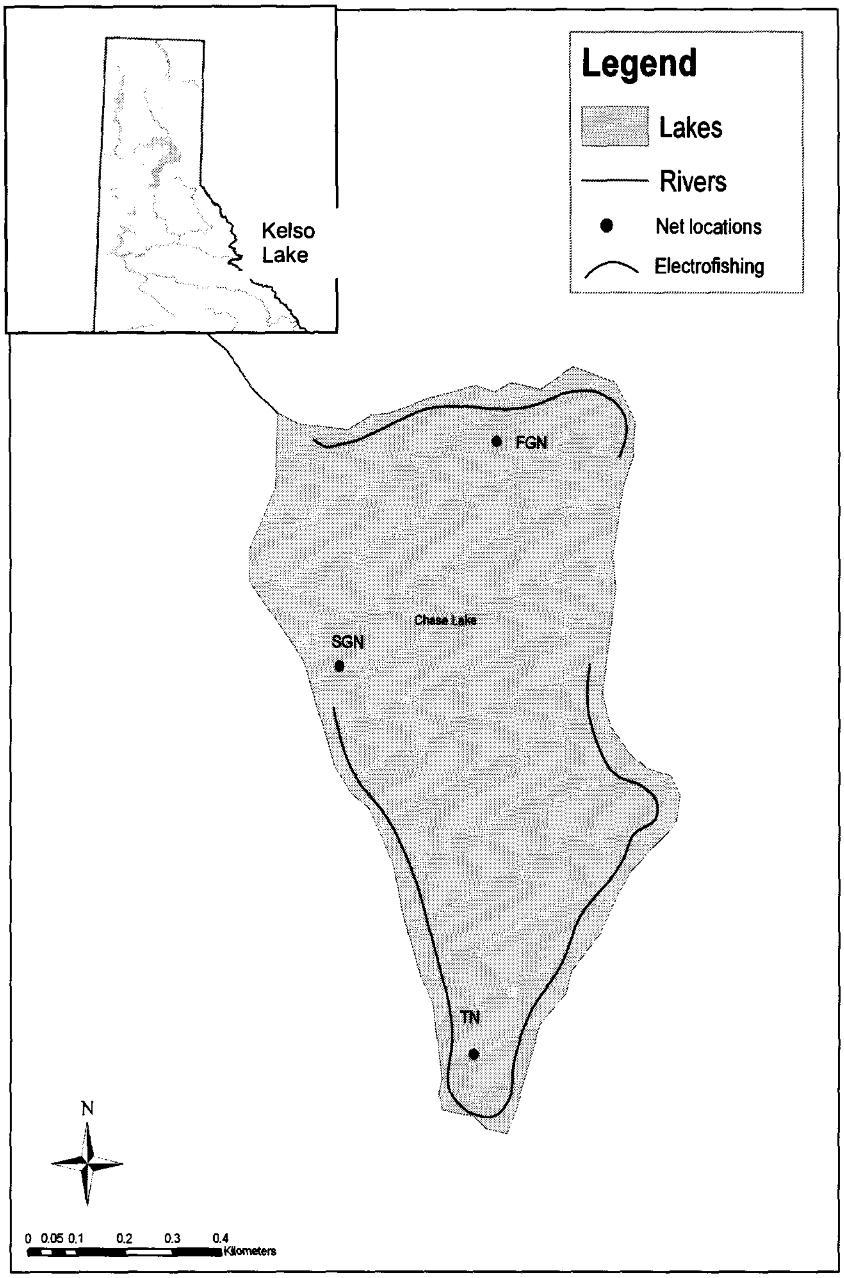


Figure 23. Locations of trap net (TN), floating gill net (FGN), and sinking gill net (SGN), and shoreline electrofishing during a lowland lake survey in May 2008, Chase Lake, Idaho.



Kel

Figure 24. Locations of trap nets (TN1 and TN2), floating gill nets (FGN1 and FGN2), sinking gill nets (SGN1 and SGN2), and shoreline electrofishing during a lowland lake survey in June 2008, Kelso Lake, Idaho.

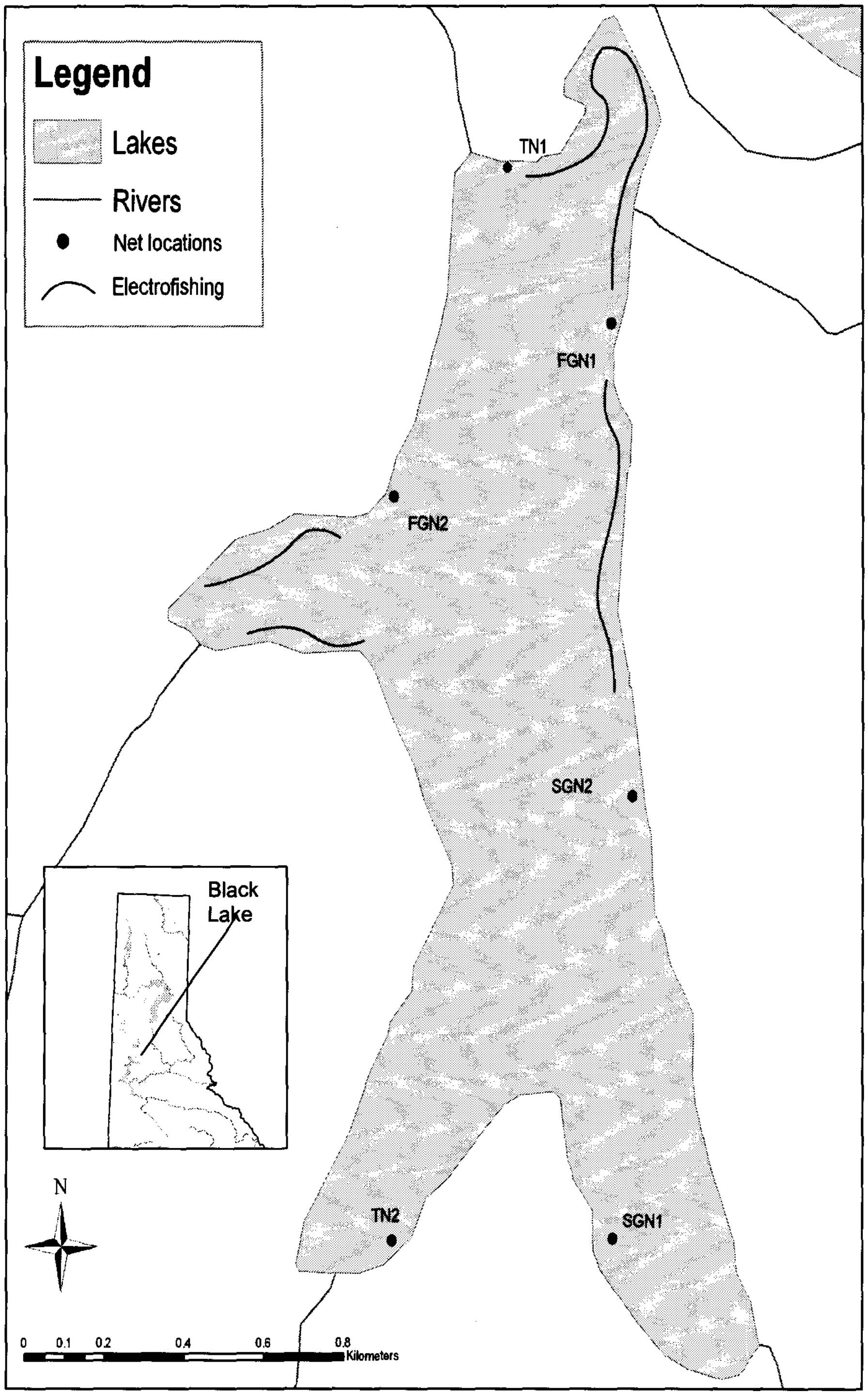
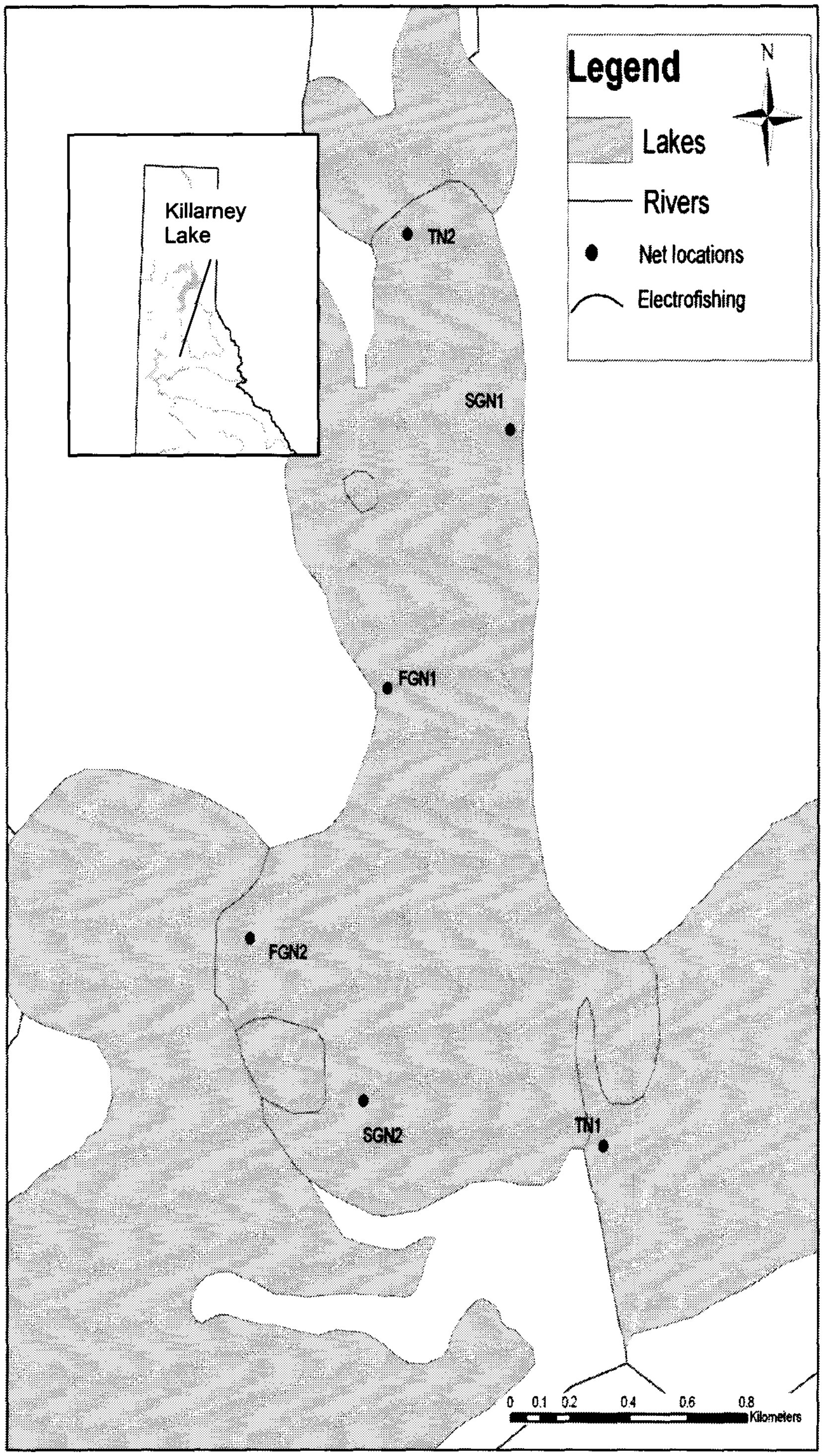


Figure 25. Locations of trap nets (TN1 and TN2), floating gill nets (FGN1 and FGN2), sinking gill nets (SGN1 and SGN2), and shoreline electrofishing during a lowland lake survey in July 2008, Black Lake, Idaho.

Figure 26. Locations of trap nets (TN1 and TN2), floating gill nets (FGN1 and FGN2), and sinking gill nets (SGN1 and SGN2), during a lowland lake survey in July 2008, Killarney Lake, Idaho.



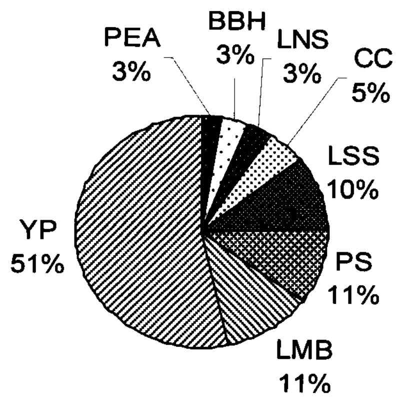


Figure 27. Relative abundance of all species by number collected during the lowland lake survey of Cocolalla Lake, Idaho, 2008. Bluegill, rainbow trout, brown trout, cutthroat trout, brook trout, and black crappie composed 1% or less of the total catch.

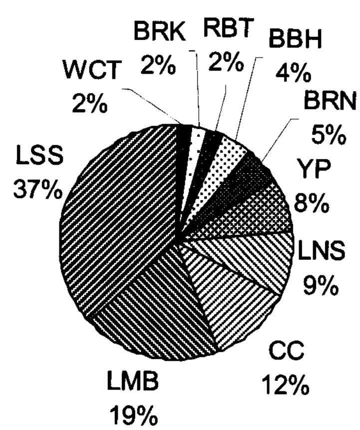


Figure 28. Relative abundance of all species by weight collected during the lowland lake survey of Cocolalla Lake, Idaho, 2008. Bluegill, black crappie, peamouth, and pumpkinseed composed 1% or less of the total biomass captured.

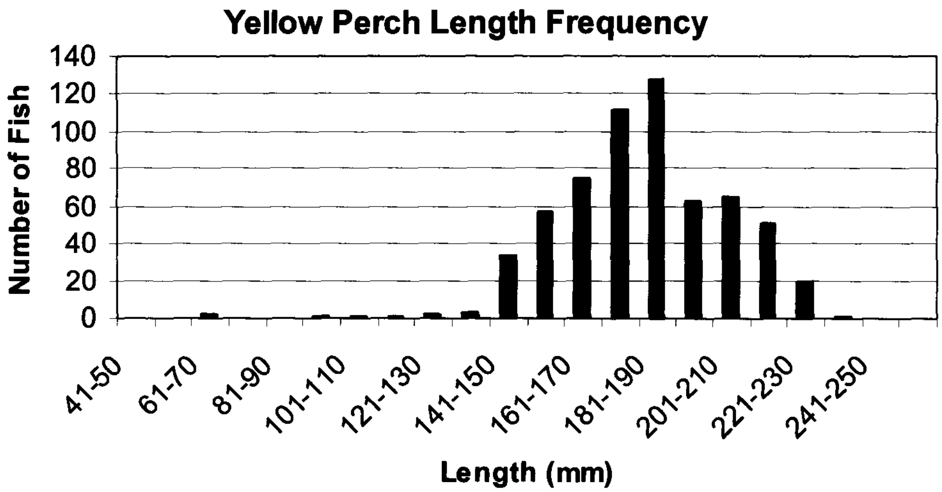


Figure 29. Length frequency of yellow perch caught during a lowlake survey of Cocolalla Lake, Idaho,2008.

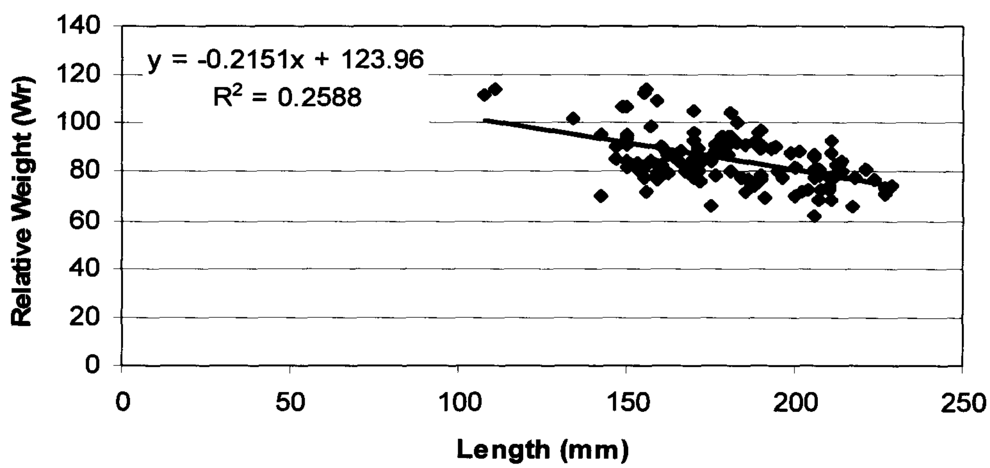


Figure 30. Regression showing the correlation between relative weight (Wr) and length (mm) of yellow perch captured during the lowland lake survey on Cocolalla Lake, Idaho, 2008.

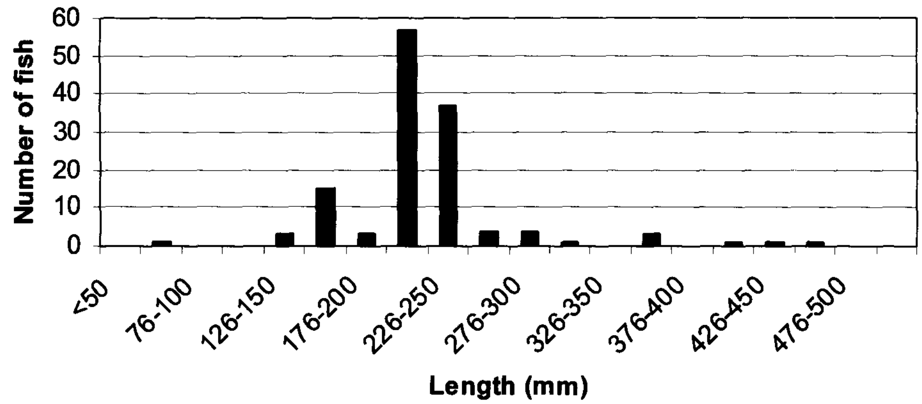


Figure 31. Length frequency of largemouth bass collected during the lowland lake survey of Cocolalla Lake, Idaho, 2008.

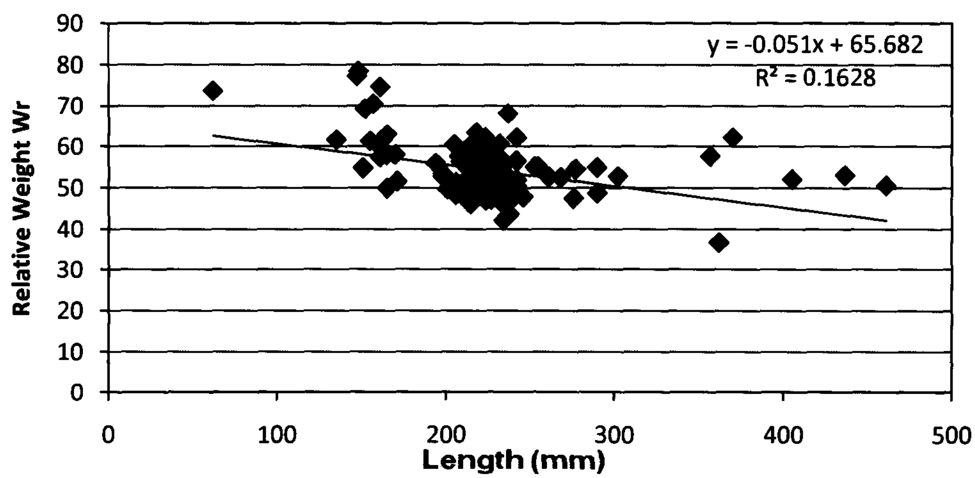


Figure 32. Regression showing the correlation between relative weight (Wr) and length (mm) of largemouth bass captured during the lowland lake survey on Cocolalla Lake, Idaho, 2008.

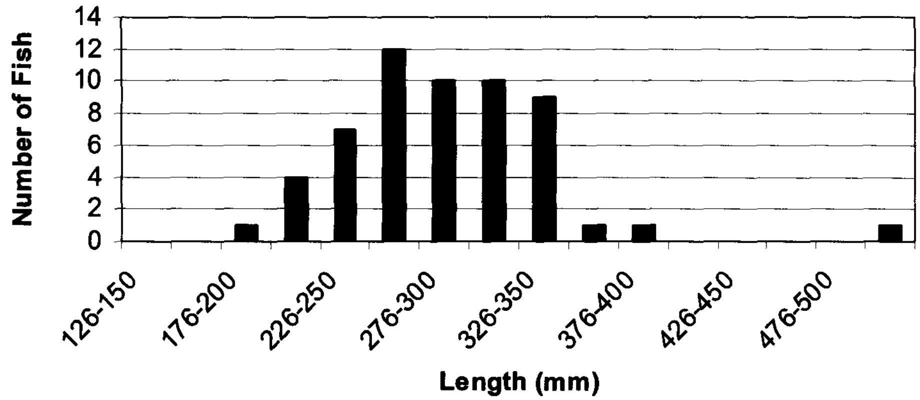


Figure 33. Length frequency of channel catfish collected during the lowland lake survey of Cocolalla Lake, Idaho, 2008.

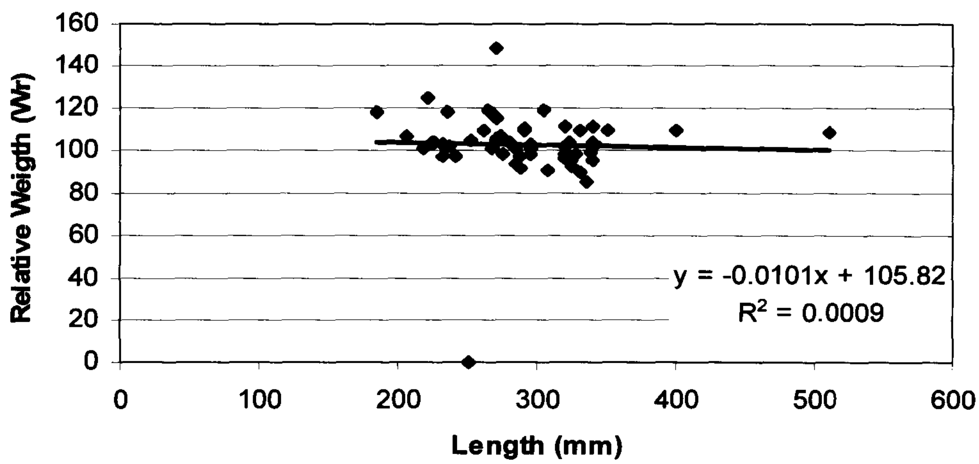


Figure 34. Regression showing the correlation between relative weight (Wr) and length (mm) of channel catfish captured during the lowland lake survey on Cocolalla Lake, Idaho, 2008.

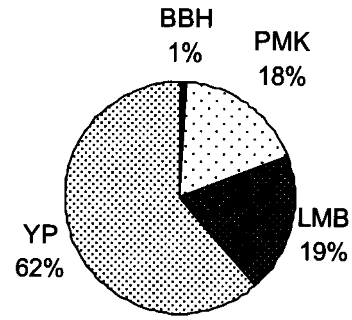


Figure 35. Relative abundance of all species by number collected during the lowland lake survey of Chase Lake, 2008.

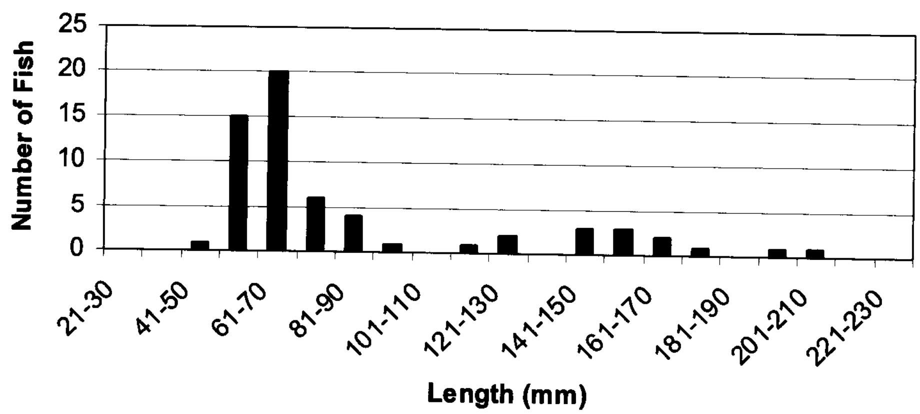


Figure 36. Length frequency of yellow perch collected during the lowland lake survey of Chase Lake, Idaho, 2008.

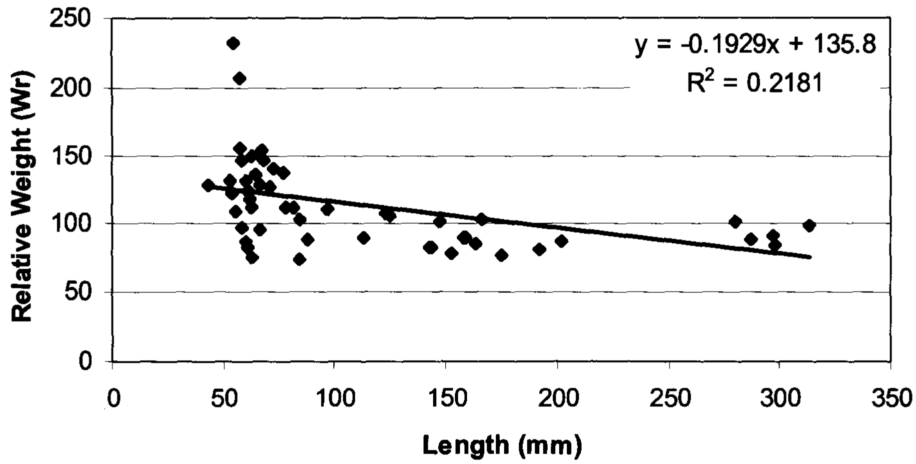


Figure 37. Regression showing the correlation between relative weight (Wr) and length (mm) of yellow perch captured during the lowland lake survey on Chase Lake, Idaho, 2008.

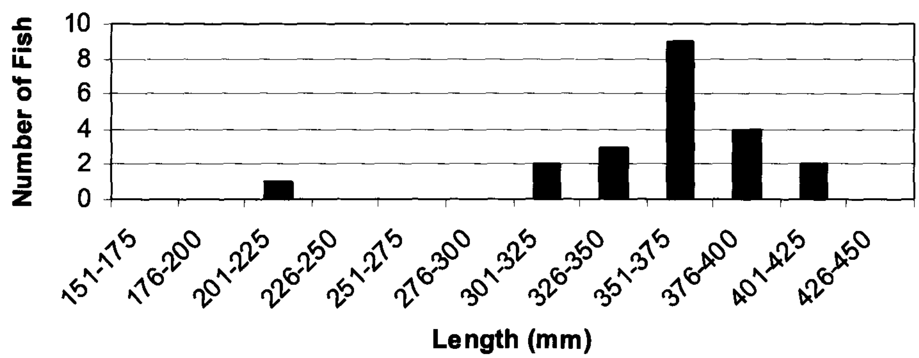


Figure 38. Length frequency of largemouth bass collected during the lowland lake survey of Chase Lake, Idaho, 2008

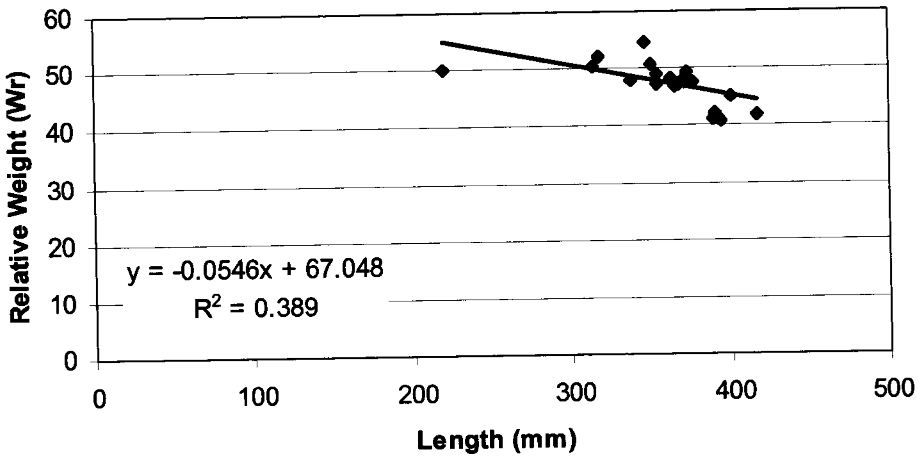


Figure 39. Regression showing the correlation between relative weight (Wr) and length (mm) of largemouth bass captured during the lowland lake survey on Chase Lake, Idaho, 2008.

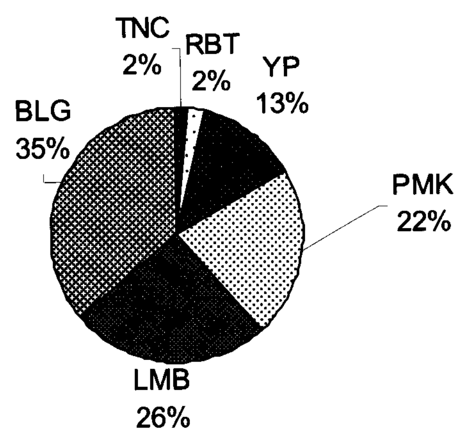


Figure 40. Relative abundance of all species by number collected during the lowland lake survey of Kelso Lake, 2008. Black crappie constituted less than 1% of the total catch.

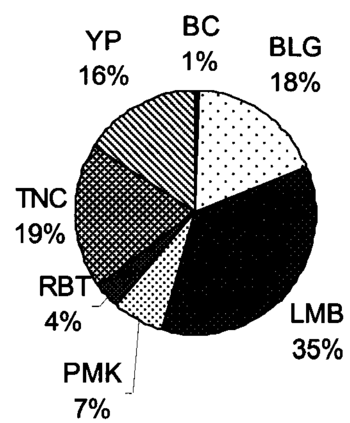


Figure 41. Relative abundance of all species by weight collected during the lowland lake survey of Kelso Lake, 2008.

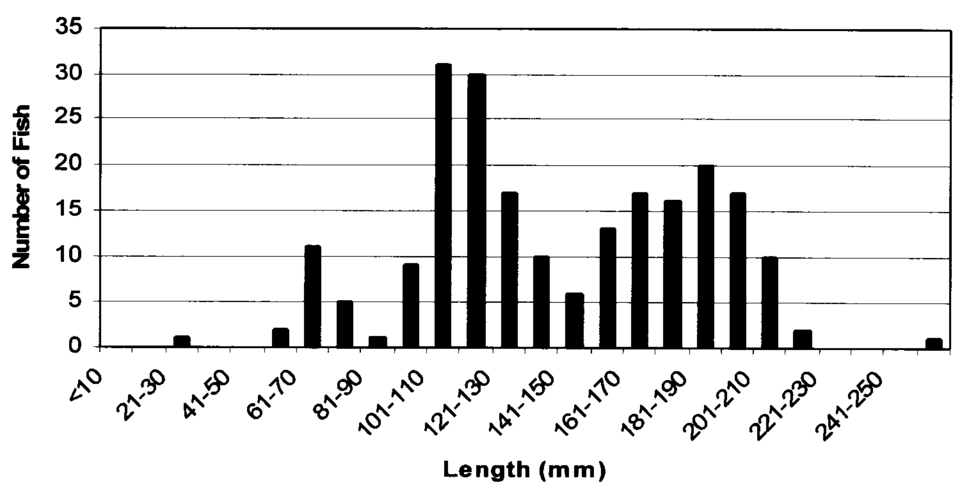


Figure 42. Length frequency of bluegill collected during the lowland lake survey of Kelso Lake, Idaho, 2008.

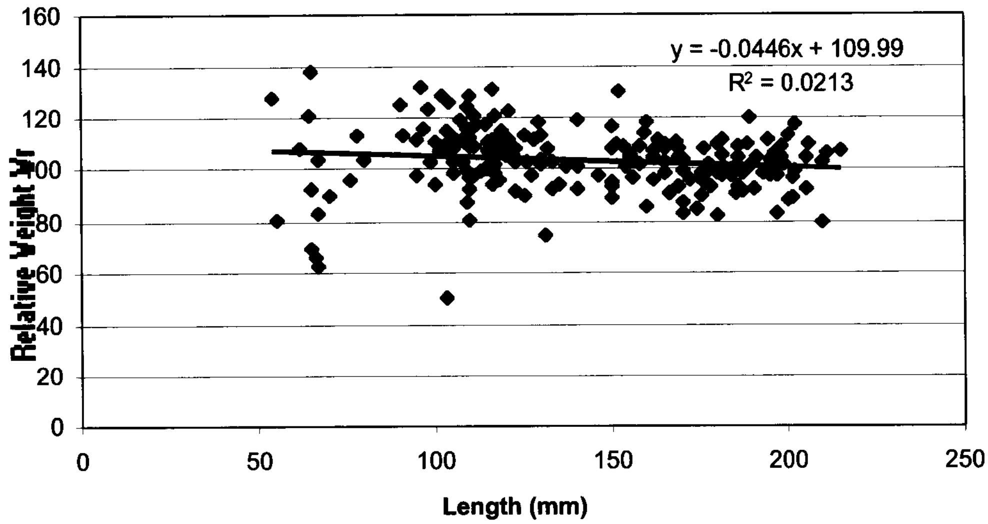


Figure 43. Regression showing the correlation between relative weight (Wr) and length (mm) of bluegill captured during the lowland lake survey on Kelso Lake, Idaho, 2008.

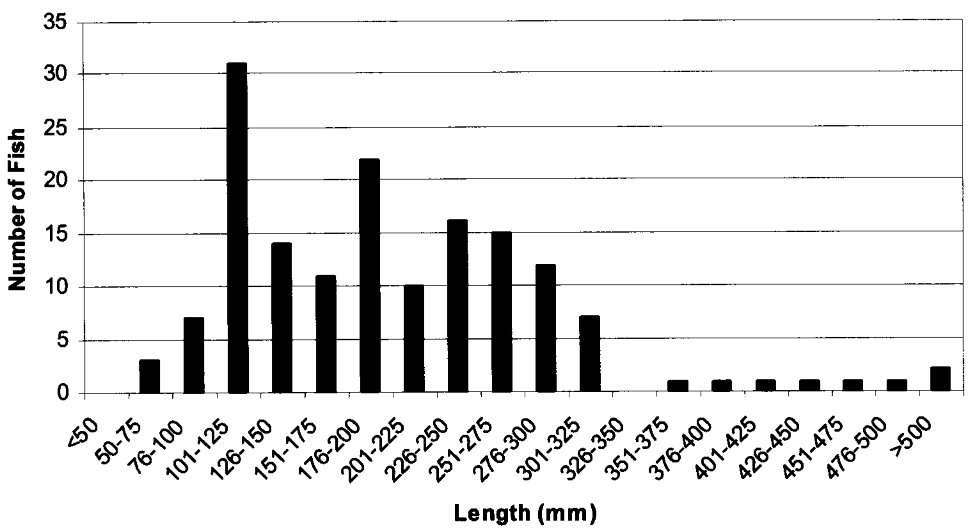


Figure 44. Length frequency of largemouth bass collected during the lowland lake survey of Kelso Lake, Idaho, 2008

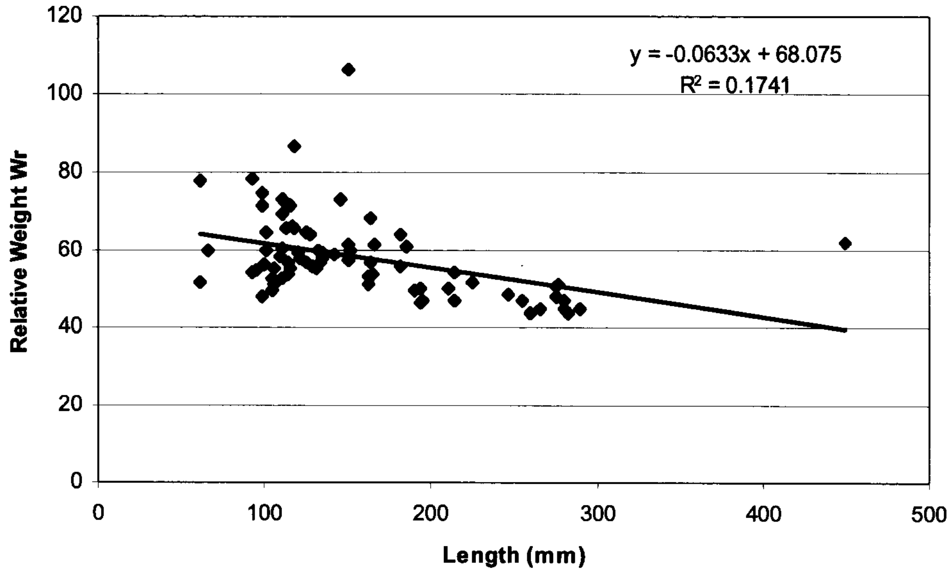


Figure 45. Regression showing the correlation between relative weight (Wr) and length (mm) of largemouth bass captured during the lowland lake survey on Kelso Lake, Idaho, 2008.

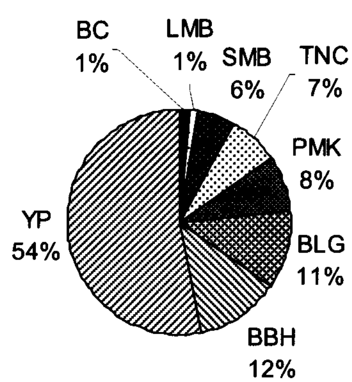


Figure 46. Relative abundance of species by number captured during the lowland lake survey of Black Lake, Idaho, 2008. Kokanee, largescale sucker, and northern pike composed less than 1% of the total catch.

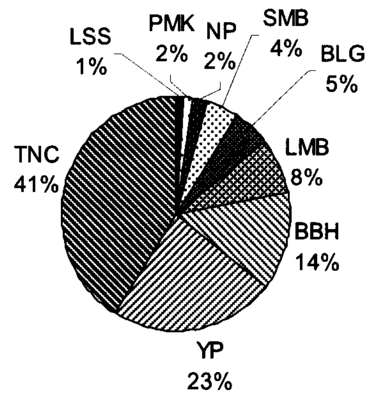


Figure 47. Relative abundance of species by biomass captured during the lowland lake survey on Black Lake, Idaho, 2008. Kokanee and black crappie biomass composed less then 1% of the total catch.

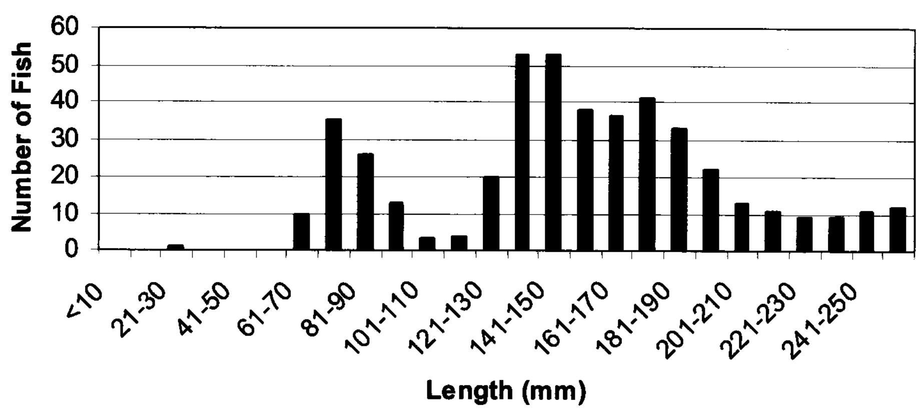


Figure 48. Length frequency of yellow perch collected during the lowland lake survey of Black Lake, Idaho, 2008

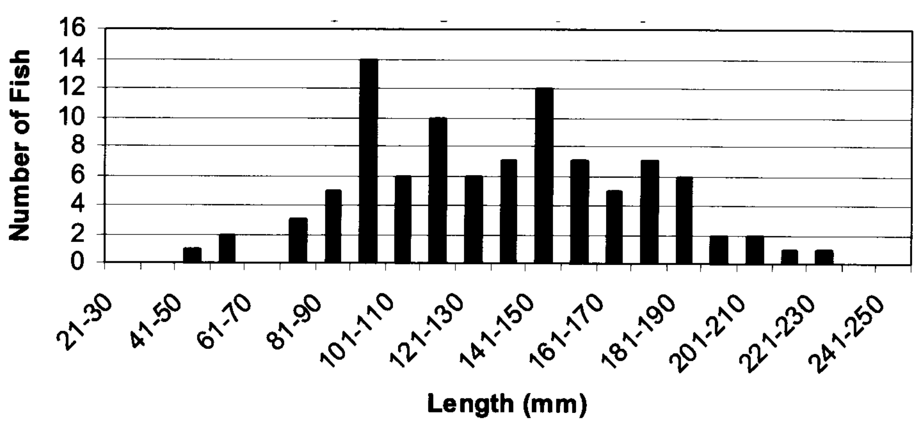


Figure 49. Length frequency of bluegill collected during the lowland lake survey of Black Lake, Idaho, 2008.

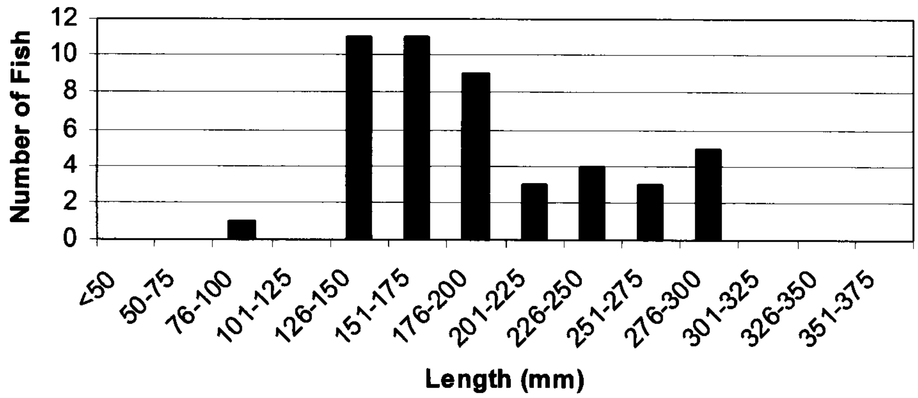


Figure 50. Length frequency of smallmouth bass collected during the lowland lake survey of Black Lake, Idaho, 2008.

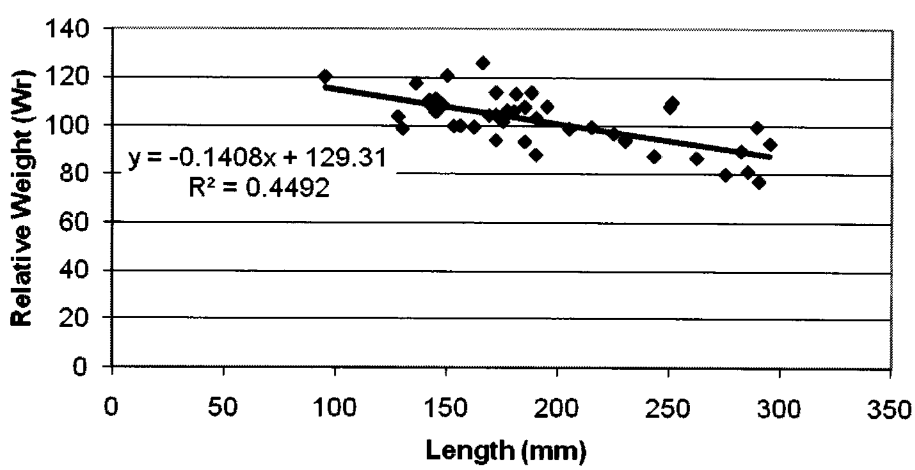


Figure 51. Regression showing the correlation between relative weight (Wr) and length (mm) of smallmouth bass captured during the lowland lake survey on Black Lake, Idaho, 2008.

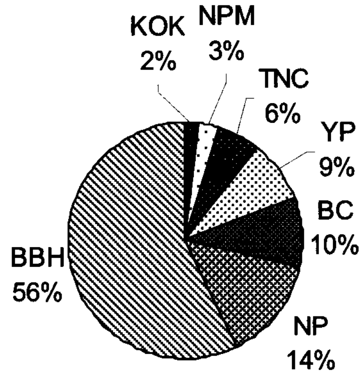


Figure 52. Relative abundance of species by number of fish captured during the lowland lake survey of Killarney Lake, Idaho, 2008. Bluegill and largemouth bass composed only 1% of the total catch. No electrofishing was included in this effort.

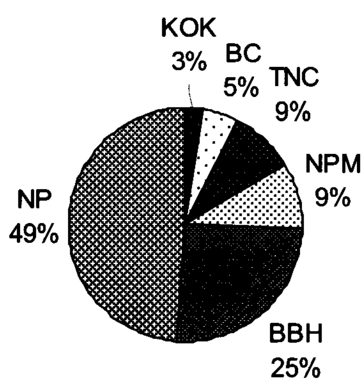


Figure 53. Relative abundance of species by biomass of fish captured during the lowland lake survey of Killarney Lake, Idaho, 2008. Bluegill, yellow perch and largemouth bass composed 1% or less of the total biomass. No electrofishing was included in this effort.

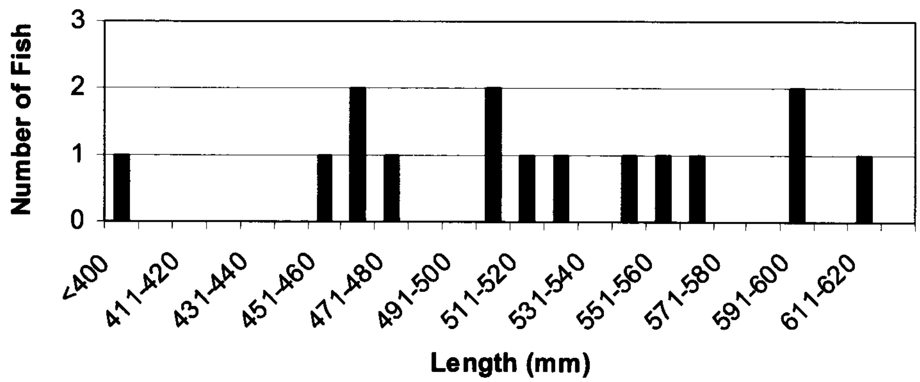


Figure 54. Length frequency of northern pike collected during the lowland lake survey of Killarney Lake, Idaho, 2008.

Table 11. Lake survey results from Chase Lake, Idaho, May 2008 (electrofishing, gill and trap net); June, 1994 (gill and trap net); and August, 1984 (gill net).

Year	Species	Number collected	Mean length (mm)	Length range (mm)	Relative abundance by number caught
2008	Largemouth bass	21	359	219-417	19%
	Yellow perch	67	104	43-313	62%
	Pumpkinseed	20	73	32-221	18%
	Brown bullhead	1	387	387	1%
1994	Largemouth bass	22	217	190-330	22%
	Yellow perch	48	275	170-320	49%
	Pumpkinseed	6	167	150-210	6%
	Brown bullhead	22	322	280-370	22%
1984	Largemouth bass	10	247	205-325	10%
	Yellow perch	85	223	175-295	81%
	Pumpkinseed	7	178	105-215	7%
	Brown bullhead	3	302	175-295	3%

2008 PANHANDLE REGION FISHERY MANAGEMENT REPORT

BULL TROUT REDD COUNTS

ABSTRACT

In September and October 2008, with the help of multiple agency personnel, we conducted bull trout redd counts in the Priest, Kootenai, Pend Oreille, and Little North Fork of the Clearwater basins. These counts were added to trend data sets used to track changes in bull trout spawning escapement numbers throughout the Panhandle Region.

We counted 22 redds in tributaries to Upper Priest Lake, 7 in Lower Priest Lake basin, 584 bull trout redds in the Pend Oreille Lake basin, 17 redds in tributaries to the Kootenai River, 113 redds in the St. Joe River drainage, and 86 redds in tributaries to the Little North Fork of the Clearwater River.

Consistently improving trend counts were only seen in the St. Joe River tributaries. Little North Fork of Clearwater was improving until 2007; however 2008 counts were about 25% lower than the 2006 and 2007 counts. Although Pend Oreille Lake redd counts showed a similar increasing trend until 2006, recent counts (2007 and 2008) were about 50% lower than they were in 2006. Upper Priest Lake and Kootenai River tributaries showed an improvement from 2007 counts; however, the apparent overall trend is currently on the decline for these two systems.

In 2008, none of these bull trout core areas met any of the four recovery criteria identified in the Bull Trout Draft Recovery Plan for the population to be considered "recovered."

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INTRODUCTION

Due to anthropogenic influences (habitat degradation, exotic species introduction, and over harvest), bull trout populations across the Pacific Northwest have experienced widespread declines (Rieman et al. 1997). As a result, bull trout were listed as threatened in 1998 under the Endangered Species Act.

Soon after the listing, the following five core areas, which are located within or at least partially within the Idaho Panhandle, were identified: Priest Lake, Pend Oreille Lake, Kootenai River, Coeur d'Alene Lake, and the North Fork Clearwater River (USFWS 2002).

The recovery goal for bull trout, as identified in the Bull Trout Draft Recovery Plan, is to ensure the overall longevity of self-sustaining, complex, and interacting groups of bull trout in order that they may one day be de-listed (USFWS 2002). In order to accomplish this goal, recovery criteria addressing distribution, abundance, habitat and connectivity were identified for each of these core areas (Table 12; USFWS 2002).

In order to evaluate the status of bull trout populations in the core areas, redd counts have been historically used as an index of population strength. In addition, since work from Baxter and Westover (1999) and Downs and Jakubowski (2003) found that repeat spawning is common for adfluvial bull trout, the expansion of redd counts to number of adults in the population may be relatively similar.

Bull trout redds are conducted in each of the core recovery areas to monitor long term trends in these populations. Redd counts not only allow us to evaluate the status of the populations in these areas as they pertain to each of the recovery criteria, but they also help in directing future management and recovery activities.

STUDY SITES

Bull trout redds were counted in tributaries of the Priest River, Pend Oreille Lake, Kootenai River, St. Joe River, and Little North Fork Clearwater River drainages where bull trout were believed to spawn (Figures 55, 57, 59, 62, and 64). These watersheds make up all or part of five different core areas that occur in the IDFG Panhandle Region (USFWS 2002). These core areas are Priest Lake, Pend Oreille Lake, Kootenai River, Coeur d'Alene Lake and North Fork Clearwater River. The boundary of the Kootenai River and North Fork Clearwater River core areas span outside of the Panhandle Region. Selection of survey streams was dependent on available time and results of previous surveys. Streams where no redds were found for several consecutive years were often discontinued to allow more time to investigate new streams.

OBJECTIVES

1. Quantify bull trout redds and spawning escapement in Priest Lake, Pend Oreille Lake, Kootenai River, Coeur d'Alene Lake and North Fork Clearwater River core areas.

2. Assess whether bull trout abundance in each of the core areas meets recovery criteria outlined in the federal Bull Trout Draft Recovery Plan.

3. Survey additional streams to assess occurrence of bull trout spawning.

METHODS

Bull Trout Spawning Surveys

Bull trout redds were counted in selected tributaries of the Priest Lake, Priest River, Pend Oreille Lake, Kootenai River, St. Joe River, and Little North Fork of the Clearwater River basins where bull trout were known or believed to occur. Counts in each of these basins were summarized in the core area they occurred in. Redd counts in the Middle Fork East River, North Fork East River and Uleda Creek (tributaries of Priest River) were added to the Pend Oreille Lake Core Area in 2003 when these bull trout were documented to spend their adult life in Pend Oreille Lake (DuPont et al. In Press). All redds were counted at similar times (September and October) as had occurred in the past (DuPont et al., In Press). Survey techniques and identification of bull trout redds followed the methodology described by Pratt (1984). Research has demonstrated the level of observer training and experience may influence the accuracy of redd counts (Bonneau and LaBar 1997; Dunham et al. 2001). To reduce observer variability in bull trout redd counts, attempts were made to use only those individuals who attended a bull trout redd count training exercise on September 23, 2008. To add to our knowledge on preferred bull trout spawning areas and to help evaluate recovery efforts, the location of redds was recorded on maps and/or GPS units during redd counts. Sections of the Kootenai River and North Fork Clearwater core areas occurred outside the Panhandle Region. Redd count data for these areas were obtained from the personnel responsible for conducting these surveys.

Data Analysis

To estimate the spawning escapement or population abundance (depending on recovery area) of bull trout in streams, we used Downs and Jakubowski (2006) findings where on average, 3.2 adult bull trout entered tributaries of Lake Pend Oreille for every redd that was counted during annual redd count surveys. We decided to use this adult to redd ratio because this estimation came from one of the core areas in the Panhandle Region, and because it is the same as Fraley and Shepherd (1998) found in the Flathead Lake system. Baxter and Westover (1999) and Downs and Jakubowski (2003) found that repeat spawning is common for adfluvial bull trout where 90-100% of the surviving bull trout spawned in consecutive years. For this reason we decided to use the total spawning escapement calculated from redd counts from the Priest, Pend Oreille and Coeur d'Alene Lake core areas as an estimate for the total number of adults that occurred there. We recognize this will give us a conservative estimate, as bull trout in every tributary in the Panhandle do not spawn every year (DuPont et al., In Press; Downs and Jakubowski 2006; Rieman and McIntyre 1996). The one exception to this is for the Little North Fork Clearwater, where research by Schriever and Schiff (2002) found that anywhere from 50-75% of the adult bull trout return to spawning grounds in consecutive years. Consequently, for the Little North Fork Clearwater River we multiplied the spawning escapement by 1.33 (75% repeat spawners) to estimate how many adults occurred in the core area. In order to estimate the total spawning escapement in the Little North Fork Clearwater River, we added 18% to the redd total to account for streams not surveyed in 2008 (Buck Creek represented 10% of the redds in 2003; Rocky Run 6% in 2007; and 2% more added for main Little North Fork Clearwater River not walked).

To evaluate whether the population of adult bull trout in each core area was stable or increasing, we used a linear regression with sample year as the independent variable and the number of redds as the dependent variable. Other studies have used regressions to evaluate whether bull trout populations were stable or increasing; however, in each of these cases they either used non-parametric techniques (Rieman and Myers 1997) or converted the redd counts using a $\log_e$ transformation (Maxell 1999). We did not convert the data or use non-parametric techniques because we believe it is easier for most individuals to visualize trends and understand how bull trout abundance is changing if the actual redd count data are used (no transformation or ranking of the data).

For a simple linear regression, if the slope of the regression line is greater than or equal to zero and 10 or more years of redd count data exists, then a bull trout population can be considered as stable or increasing. A significant ($P < 0.10$) slope of the regression line was preferred to assess whether a particular population is stable or increasing; however, we did not rely solely on a statistically significant relationship. As the abundance of individuals in a population reaches its carrying capacity and/or stabilizes (slope of regression line near zero), there is no significant relationship. When a statistically significant relationship ($P < 0.10$) does not occur, interpretation and professional judgment must be used to determine if the amount of variation seen around a regression line is too great for a particular population to be considered stable or increasing.

RESULTS

Priest Lake Core Area

A total of 22 bull trout redds were counted in the Upper Priest River basin on October 1, 2008 (Figure 55 and Table 13). The majority of these redds were counted in Upper Priest River (21 out of 22). In the lower Priest Lake, the North Fork Indian Creek and North Fork of Gold Creek, tributaries of Priest Lake were also surveyed, and seven total bull trout redds were observed (two in N.F. Indian and five in N.F. Gold). The number of redds counted in Upper Priest basin were four times lower than what was counted in 1985 when similar reaches were compared (Figure 56; Table 14). By expanding the number of redds observed by 3.2 fish/redd, we calculated the spawning escapement of bull trout to be 70 fish for the Upper Priest Lake basin and 22 for the lower lake (92 total). Since 1985, a significant ($P = < 0.001$) downward trend across consistently surveyed sites is evident in the abundance of spawning bull trout in the Priest Lake Core Area (Figure 56; Table 14).

One man-made barrier was noted during our survey that we believe blocks upstream migration of bull trout. This barrier is a U.S. Forest Service culvert located where F.S. road 1013 crosses Gold Creek N 48° 49' 0.702"; W 116° 59' 39.392" (T63N, R5W, Section 17).

Pend Oreille Lake Core Area

Bull trout redd counts were completed between October 9, 2008 and October 17, 2008 in 19 tributaries to Lake Pend Oreille (LPO) and the Clark Fork River spawning channel (Figure 57). Bull trout redds were counted in Pend Oreille River tributaries including the Middle Fork

East River and Uleda Creek of the Priest River drainage. Redd counts ranged from a low of zero redds in the Clark Fork River to a high of 183 redds in Trestle Creek (Table 15). A total of 584 bull trout redds were observed across all sample locations. Index streams surveyed since 1983, accounted for 382 of the total observed redds in 2008. Based on 2008 LPO drainage redd counts the expanded adult bull trout spawning population consisted of an estimated 1,872 fish (Table 16). Six local populations were estimated to have more than 100 adult spawning fish.

Regression analysis of bull trout redd counts from the LPO core area across years continued to demonstrate an increasing trend in relative abundance of LPO bull trout. Positive population trends were observed collectively in both index streams and all streams surveyed from 1983 to 2008 (Figure 58). However, a significant trend ($\alpha \leq 0.1$, $P = 0.03$) in LPO bull trout redd counts was only observed in analysis including counts in surveyed streams from 1992 to 2008 (Table 14). A separate analysis of all streams surveyed was included for survey years from 1992 to 2008 because a data gap in the time series existed where only index streams were surveyed during the period from 1988 to 1991 (Table 15). Redd count values from 1995 were excluded from analysis because counts in most reaches were compromised by high turbid water in that year.

Despite a positive core area trend in bull trout redd counts, several individual stream stocks in the LPO drainage demonstrated declines in annual counts (Table 15). Declines in redds counted from 2007 were encountered in Granite, Grouse, Gold, North Gold, and Sullivan Springs creeks as well as the Pack River. Although an increase in bull trout redds was observed in Trestle Creek in 2008, counts continued below average following a dramatic decline in 2007. Bull trout redds counted in Granite, Gold, and Trestle creeks combined represented 53% of all redds observed in the LPO core area in 2008 despite low counts in these streams.

Kootenai River Core Area

Three tributaries (North Callahan, South Callahan and Boulder creeks) were surveyed on October 9 and 10, 2008 for bull trout redds in the Idaho portion of the Kootenai River Core Area, and a total of 17 redds were counted (Figure 59; Table 17). This was the seventh year surveys were conducted in all three of these tributaries. Redd counts were up from 2007 (three redds counted), but were about average when compared to the past seven years of sampling. By expanding the number of redds observed by 3.2 fish/redd, we calculated the spawning escapement of bull trout for the Idaho portion of the Kootenai River Core Area to be 54 fish.

The current seven year trend is negative, yet with only seven years of redd counts occurring on the three Idaho Kootenai River tributaries, trend analysis are still relatively unreliable (Figure 60; Table 14).

In the Montana portion of the Kootenai River Core Area, 149 redds were counted during 2008 (Table 17). This converts to an estimated spawning escapement of 477 fish. Combined with the Idaho spawning escapement (54 fish), the total spawning escapement for the Kootenai River Core Area comes out to 531 fish.

Trend analysis (linear regression) of bull trout redds in three Montana tributaries that have been counted consistently since 1990 indicate this population is significantly ($P = 0.067$) increasing (Figure 61; Table 14). Redd counts from 2002 to 2008 were lower than those between 1998 and 2001, although they were higher than what were observed between 1990 and 1996 (Figure 61). Starting in 1996, bull trout were been counted consistently in five Montana streams. Analysis of this data suggests that since 1996 the bull trout population has decreased slightly (Figure 61; Table 14).

Coeur d'Alene Lake Core Area

The IDFG and USFS counted 106 redds in the three index stream reaches of the St. Joe River drainage on September 25, 2008 (Figure 62; Table 18). The U.S. Forest Service along with the Coeur d'Alene Indian Tribe surveyed another nine streams on September 8th and 20th, 2008 and counted seven additional redds bringing the total number of redds counted in the St. Joe River drainage to 116 (Table 18). This is the highest count of redds in the drainage since counts began in 1992. The majority (94%) of all the redds were counted in the three index streams (Medicine Creek, Wisdom Creek, St. Joe River from Heller Creek to upstream barrier). As in previous years, no attempts were made to search for bull trout redds in the Coeur d'Alene River basin. Expanding the number of redds observed by 3.2 fish/redd, the spawning escapement of bull trout for the Coeur d'Alene Lake Core Area was estimated to be 362 fish. No bull trout redds were observed downstream of Red Ives Creek.

Evaluating all streams counted, an upward significant (P = 0.008) trend in the abundance of bull trout redds since 1992 was observed for the Coeur d'Alene Lake Core Area (Figure 63; Table 14). Using the three index streams, an even greater significant ($P < 0.001$) upward trend was evident (Figure 63; Table 14). Based on these significant increasing trends, we concluded that the bull trout population in the Coeur d'Alene Lake Core Area is stable or increasing.

Red Ives Creek has a diversion dam on it within 2 km of the mouth that we believe blocks upstream migration of most bull trout. Entente Creek has a culvert barrier just upstream from where bull trout redds have been reported in the past, and there appears to be suitable habitat upstream of the culvert. Other barriers may exist in streams that we believe have the potential to support spawning and rearing bull trout populations.

North Fork Clearwater River Core Area

IDFG and USFS crews counted 86 redds in the upper Little North Fork Clearwater River basin on September 25, 2008. (Figure 64 and Table 19). Counts were lower this year than in 2006 and 2007. Due to their remote location, we did not survey Canyon Creek or Buck Creek in 2008.

Adding the 18% (15 redds) to account for streams not surveyed in 2008 and expanding this corrected number of redds (101) by 3.2 fish/redd, the spawning escapement of bull trout for the upper Little North Fork Clearwater River was estimated to be 323 fish.

USFS personnel counted 89 redds in the North Fork Clearwater River and Breakfast Creek drainages in 2008 (Table 20). As with the Little North Fork Clearwater River, not all streams were surveyed in the North Fork Clearwater River drainage due to their remoteness. Based on previous redd counts (Table 20), it is believed that during 2008 about 24% of redds were not counted due to unsurveyed streams. By expanding this corrected number of redds (117) by 3.2 fish/redd, the spawning escapement of bull trout for the North Fork Clearwater River and Breakfast Creek drainages was estimated to be 325 fish. When combined with the upper Little North Fork Clearwater River, this gives us a total spawning escapement of 701 bull trout for the North Fork Clearwater River Core Area. We multiplied the spawning escapement by 1.33 (at least 25% are not repeat spawners), which gives us a total of 932 adult bull trout in the North Fork Clearwater River Core Area during 2008.

Index stream counts in Lund Creek, Little Lost Lake Creek, Lost Lake Creek and the Little North Fork Clearwater upstream of Lund Creek show an increasing trend (Figure 65; Table 14). Total Little North Fork Clearwater River and North Fork Clearwater redd counts from 2001 to 2008 also show an increasing trend over about 28 streams (Figure 66; Table 14).

DISCUSSION

Priest Lake Core Area

It is well documented that the bull trout population in the Priest Lake Core Area is in decline and at risk of collapse (Mauser 1986; Fredericks et al. 2002; DuPont et al. 2006). Although the 2008 redd counts in the Priest Lake basin were up since 2007, it was the second lowest recorded redd count since surveys began in 1983. The current adult number in the Upper Priest Lake of 70 fish falls short of the recovery goal of 1,000 fish with at least five local populations having over 100 adults, as identified in the Bull Trout Draft Recovery Plan (Table 12 and 21; USFWS,2002).

The primary cause for the rapid decline in the bull trout population in the basin has been identified as the expanding population of lake trout (Fredericks et al. 2002; Donald and Alger 1993). In addition to predation by lake trout of sub-adults entering the lake, juvenile bull trout also face predation and competition by non-native brook trout in all the rearing tributaries to both the upper and lower Priest Lake.

Although efforts have been made to reduce brook trout and a great deal of effort to reduce lake trout has been performed in the past decade, removal efforts have been ineffective at controlling the numbers of these two invasive species in Upper Priest Lake. IDFG removed over 5,000 lake trout at a rate of over 500 lake trout a year between 1997 and 2006 (DuPont et al. 2008). During 1998, it was estimated that about 75% of the lake trout (912) were removed from Upper Priest Lake, (Fredericks et al. 2002). Current information indicates that despite these removal efforts lake trout abundance more than doubled between 1998 and 2007. It is unclear whether lake trout production is from spawning activity in the upper lake or primarily from immigration of fish from the main lake through the Thoroughfare. Even if migration through the Thoroughfare is identified as being significant, there unfortunately may not be a current technological fix to eliminate this threat.

Few of the tributaries of Priest Lake have been surveyed for redds since 1986 when Mauser (1986) documented the collapse of this population. Bull trout have been observed in some of the tributaries of Priest Lake (DuPont et al. 2008), but probably contribute few adult fish to the entire core area. Several attempts at redd counts were made in the mid-1990s in the lower lake tributaries; however, this is the first year that redds had been counted in N.F. Indian and N.F. Gold Creek since 1985. We observed seven redds in these tributaries, which is a fraction of what they produced in mid-1986.

One man-made barrier (USFS culvert on F.S. Road 1013 crosses Gold Creek (T63N, R5W, Section 17) was noted during our survey that we believe blocks upstream migration of bull trout. Currently, bull trout habitat below this culvert is not fully utilized; however, spawning and rearing habitat should not be artificially limited for this depressed population.

In response to the declining population of bull trout in the Priest Lake Core Area, we suggest that options be explored to preserve what little genetic material is still left in the basin. Conservation of fisheries genetic material has been successful through cryopreservation of spermatozoa (Rana 1995) and was an option that was considered in the Priest Lake Core Area (DuPont et al. 2006). Another possibility to consider is gene banking live fish into high mountain lakes.

Pend Oreille Lake Core Area

Three of the four LPO recovery objectives (Table 12) provided in the U.S. Fish and Wildlife Service Bull Trout Draft Recovery Plan (Plan) (USFWS 2002) were met in 2008. The LPO bull trout population met the criteria of having six local populations with greater than 100 individuals in each (seven in 2004; ten in 2005; six in 2006; six in 2007). Relative abundance measured annually by redd counts suggested collectively the LPO core area is increasing in overall adult escapement. This trend was significant between 1992 and 2008. In addition, efforts continue throughout the recovery area to maintain the current distribution of bull trout and restore their distribution in previously occupied areas. However, the population abundance recovery objective was not met. The threshold population size established in the USFWS Plan of 2,500 adult was not met in 2008 consistent with the decline in redds counted over the last two years. All four recovery goals were met between 2002 and 2006.

Despite a positive trend in cumulative LPO bull trout redd counts, the 2008 index stream count and all combined stream counts represented the second year of decline in redd totals following 2006. Redd counts in 2006 represented the highest recorded cumulative count observed. The cause of decline in redd counts is uncertain, but it appears to be influenced by a small number of tributaries. Trestle, Granite, and Gold creeks have a large influence on the total number of redds counted in the entire LPO system. In 2008, Trestle and Gold creeks accounted for the majority (53%) of redds counted. Any trend analysis that lumps all of the populations together is likely to be heavily influenced by the annual variation in these three streams. Declines in the relative abundance of adult bull trout may also be influenced by incidental take associated with LPO predator removal program designed to reduce non-native lake trout that compete with native bull trout for food resources. The biggest threat to the entire bull trout population in the Pend Oreille Lake Core Area is believed to be from lake trout (LPOBTWAG 1999). Findings from Donald and Alger (1993) and Fredenberg (2002) suggest that over time bull trout will not persist in the presence of lake trout. Priest Lake and Flathead Lake, Montana experienced dramatic declines in bull trout numbers as corresponding lake trout numbers increased (Mauser 1986; Deleray et al. 1999). Considerable effort has been put into controlling the lake trout population in Pend Oreille Lake through angler incentive programs, trap netting and gill netting. However, in 2008 a total of 200 direct mortalities of bull trout occurred during predator removal. Efforts were continually made to reduce incidental take of bull trout during the programs implantation in 2008. Despite the mortalities of bull trout, long term benefits to non-native species removal are positive.

It is recommended that LPO bull trout redd counts be continued to monitor relative abundance of bull trout adults in the core area. In addition, it is recommended that limiting factors to recruitment of spawning adult bull trout in Trestle, Granite, and Gold Creek be investigated. Continued monitoring of incidental take from the LPO predator removal program is important and should be continued in combination with exploration of other methods for reducing bull trout mortality. Watershed restoration projects aimed at providing physical habitat for native fish populations should be a priority throughout the basin.

Kootenai River Core Area

In the Idaho portion of the Kootenai River Core Area, North and South Callahan creeks and to a lesser extent Boulder Creek are the only streams identified as important bull trout spawning tributaries in the Idaho portion of the Kootenai River Core Area. As with other core areas, the Kootenai River redd count was higher than 2007 counts with 17 redds counted. This number, however, was the second lowest recorded since surveys began in 2002.

In terms of the entire Kootenai River Core Area, the majority of the bull trout population is located in Montana tributaries. During 2008, 88% of redds were counted in Montana. Previous radio tracking data indicates that fish spawning downstream of the falls in North and South Callahan creeks and O'Brien Creek are mostly adfluvial coming from Kootenay Lake, B.C. Canada (Jody Walters, personal communication, IDFG). Bull trout spawning upstream of the falls in Montana (Quartz Creek, Bear Creek, Pipe Creek and West Fisher River) appear to have a fluvial life cycle where they over-winter in Kootenai River (Jody Walters, personal communication, IDFG). Taking this into consideration, we should not necessarily expect to see the same trends in bull trout abundance between these two populations. In addition, Canada allows harvest of bull trout in Kootenay Lake, which may also influence trends in the lower Kootenai River tributaries.

It appears that in 2008 none of the recovery goals were met in the Kootenai River Core Area (Table 21). The adult population size for 2008 was 531 which is about half of the recovery goal of 1,000 fish with at least five local populations having over 100 adults, as identified in the Bull Trout Draft Recovery Plan (USFWS 2002). According to past telemetry work, many bull trout below Libby Dam do not spawn every year; consequently, many more adults may have been in the core area than redd counts indicated.

Coeur d'Alene Lake Core Area

Although 12 streams were counted in the St. Joe River redd surveys, three areas (Medicine Creek, Wisdom Creek, Heller Creek and the upper St. Joe River) located in the upper St. Joe River basin were responsible for producing the 94% of the bull trout in the entire core area. No attempts were made to survey tributaries of the Coeur d'Alene River for bull trout redds. Snorkel surveys are conducted on an annual basis in the Coeur d'Alene River and no bull trout have ever been observed since these surveys began in 1973.

The 2008 redd counts were the highest since we began surveys in 1992. At least one of the bull trout recovery goals is being met in this Core Area, which is that it is a stable or increasing population (Table 21). The current population size of 362 fish, however, is much lower than the recovery population size of 1,100. The recovery goals for the Coeur d'Alene Lake Core Area should be re-evaluated to determine whether or not they are feasible.

With these few streams producing 94% of redds in the core area, there is a significant risk to extirpation should a catastrophic event take place in the near future. Understanding the need to expand the distribution of spawners, the U.S. Forest Service recently completed habitat improvements to reduce the impacts of mining on sections of Sherlock Creek, which is approximately 6.4 rkm downstream from the Medicine Creek confluence. It is believed that as a result, they counted the first redds (three; which were above the improvements) since 1999.

The recovery goal is a spawning escapement of 300 bull trout downstream of Red Ives Creek. With the exception of this year, no bull trout redds were counted below Red Ives Creek since 2002. In 2008, a single bull trout redd was counted in Simmons Creek, which is approximately 12 rkm below the Red Ives Creek confluence.

In the 1930s, bull trout were documented in most of the major tributaries in the St. Joe River and some in the St. Maries Rivers (IDFG 1933). The apparent loss of bull trout in many tributaries underscores the need to learn more about the major sources of mortality and limiting factors on the populations.

North Fork Clearwater River Core Area

There were an estimated 932 adult bull trout in the North Fork Clearwater River core area, which is considerably lower than the recovery goal of 5,000 adults (Table 12). The Core Area currently meets two of the four recovery criteria; which is that the population appears to be stable or increasing and that it meets the minimum number of local populations (USFWS 2002). The 175 redds counted this year was lower than the 221 counted in 2007 and slightly lower than the 185 redds counted in 2006. This reduction in redds counted was primarily in the Little North Fork Clearwater River where incomplete counts and fewer sections of stream being walked resulted in lower counts. Evaluation of other streams indicates that if all stream sections were sampled in their entirety, total redd counts would be similar to that in 2007. Only one stream (Little Lost Lake Creek) in the five index streams was not completely counted.

A number of streams in this core area are not counted on an annual basis due to difficulty of access, and as a result, spawning escapement in this core area is higher than the redd counts indicate. In addition, in several tributaries of the North Fork Clearwater River only short stream segments are surveyed which possibly further limits the final counts. Despite these limitations, bull trout redd counts have more than doubled in the last five years in the North Fork Clearwater River core area. If this trend continues, all recovery goals for this core area will be met in 10 years.

We suggest these remote streams in the lower North Fork Clearwater River be counted every 3-5 years in order to monitor redd numbers. Because these streams are remote in nature and buffered from human caused changes, fluctuations in redd numbers can be closer tied to potential environmental factors which have direct impacts on survival.

MANAGEMENT RECOMMENDATIONS

1. Using redd counts, continue to evaluate the status of bull trout in each of the Core areas as it relates to recovery criteria identified by the Bull Trout Draft Recovery Plan (USFWS 2002).

2. Evaluate potential for gene banking bull trout in high mountain lakes to preserve genetic material from the declining Priest Lake bull trout population.

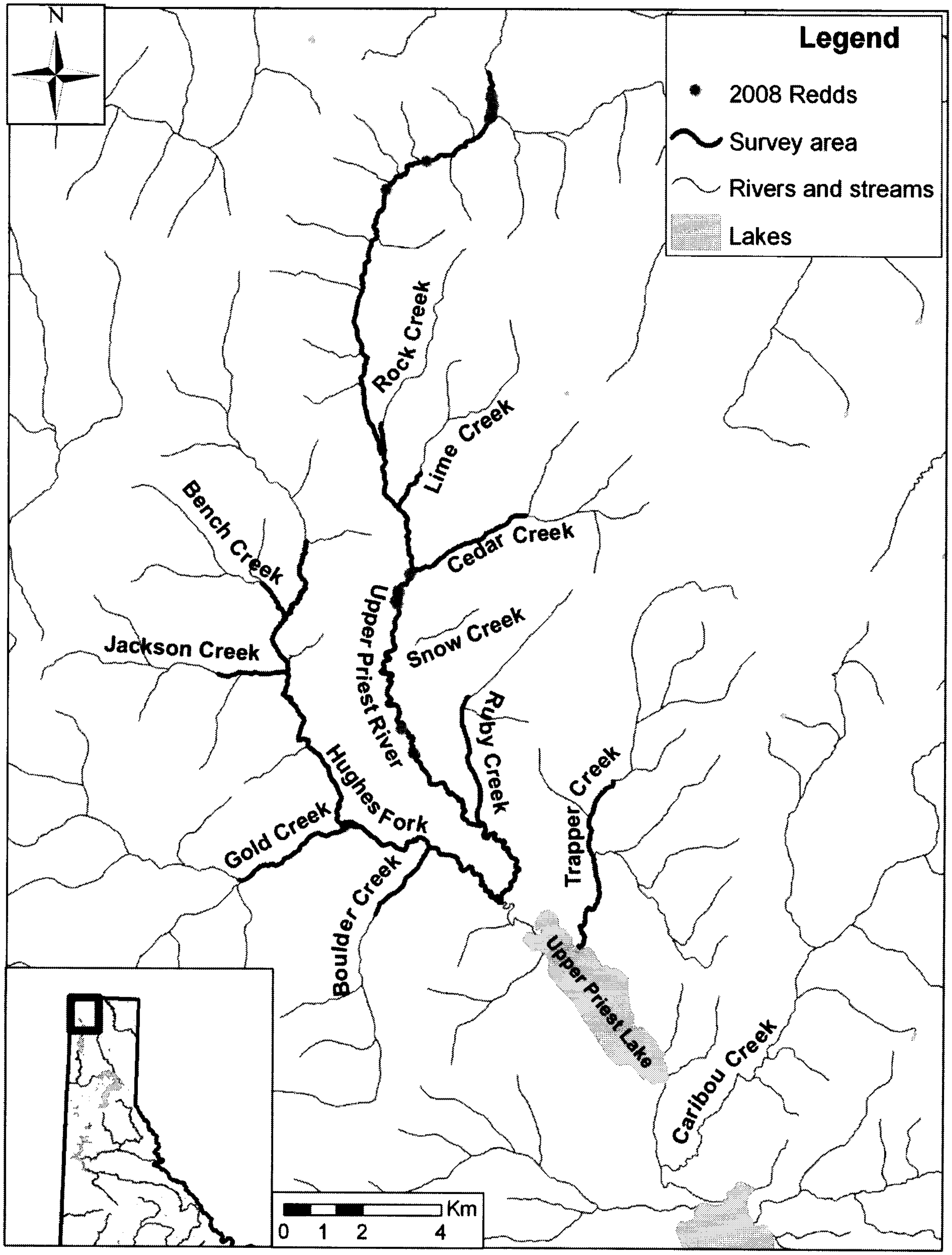


Figure 55. Stream reaches surveyed for bull trout redds in the Upper Priest Lake basin, Idaho, during October 1, 2008 and the locations of where redds were observed.

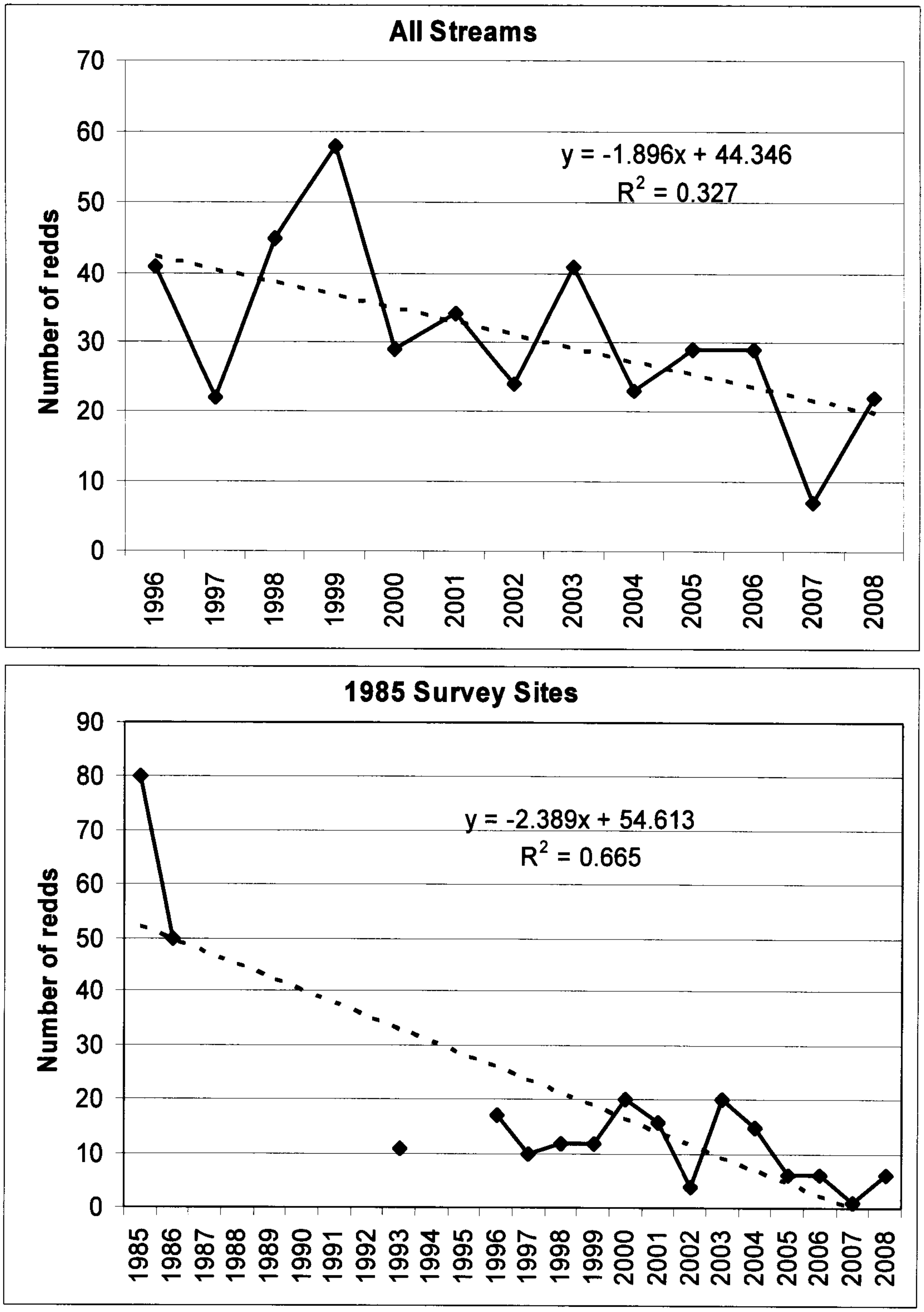


Figure 56. Linear regressions depicting trends in bull trout redd counts (all streams combined and only those sites surveyed during 1985) over time in the Priest Lake Core Area (Upper Priest Lake basin only), Idaho.

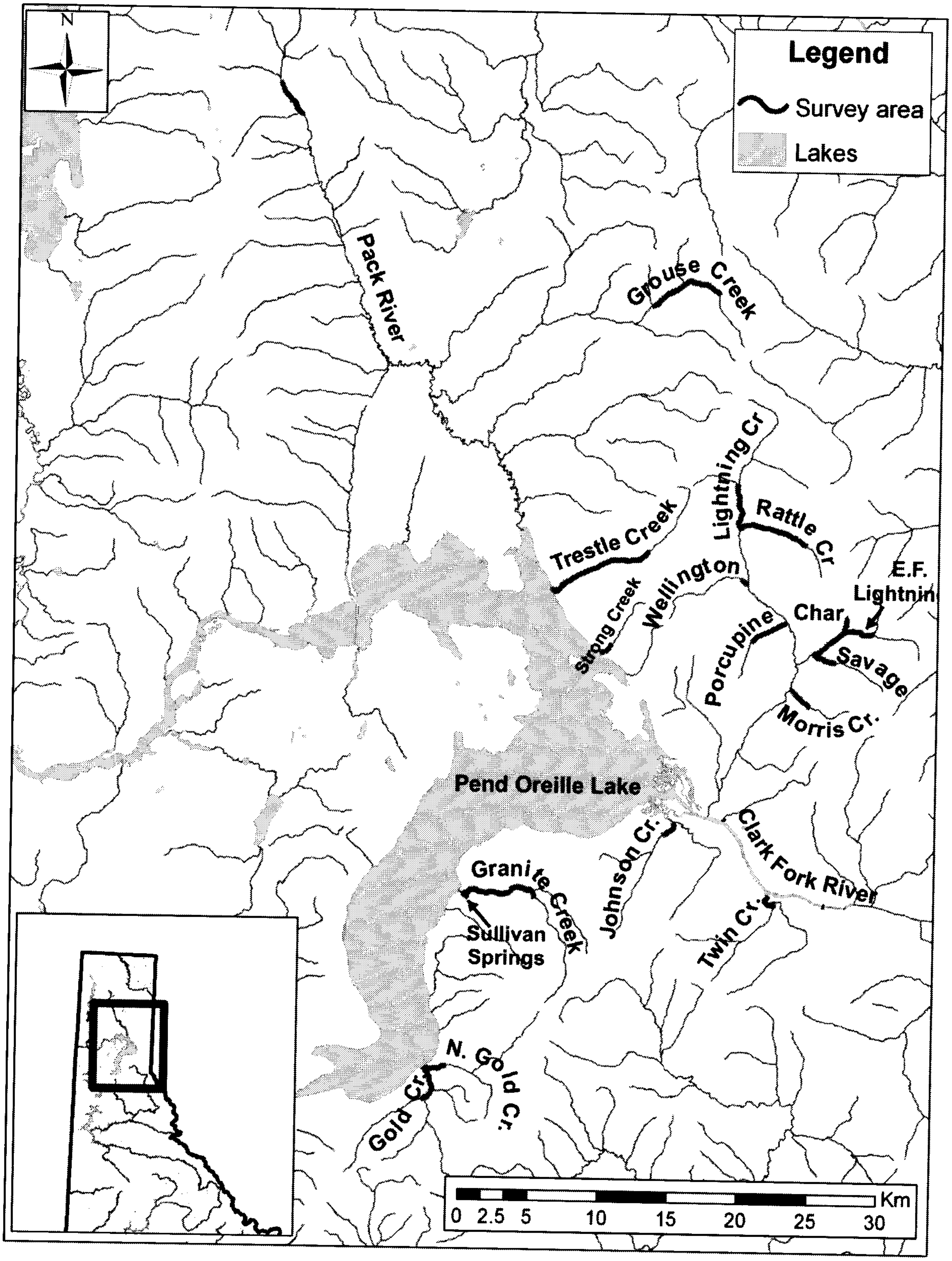


Figure 57. Stream reaches surveyed for bull trout redds in the Pend Oreille Lake basin, Idaho, on October 9-17, 2008.

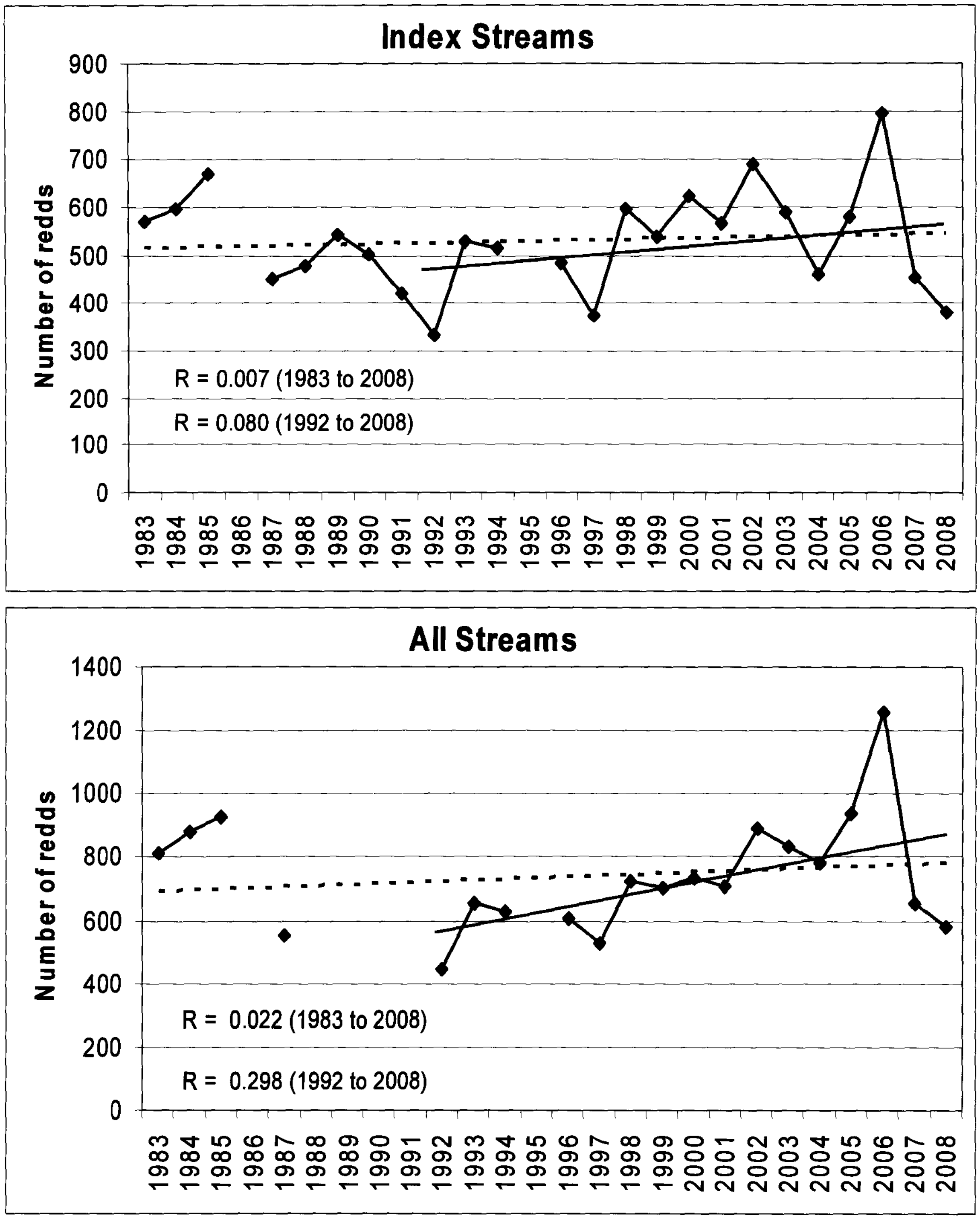


Figure 58. Linear regressions depicting trends in bull trout redd counts (six index streams and all streams combined) over time in the Pend Oreille Lake Core Area, Idaho. Dashed trend lines are for redd counts between 1983 and 2008, whereas solid trend lines are for redd counts between 1992 and 2008.

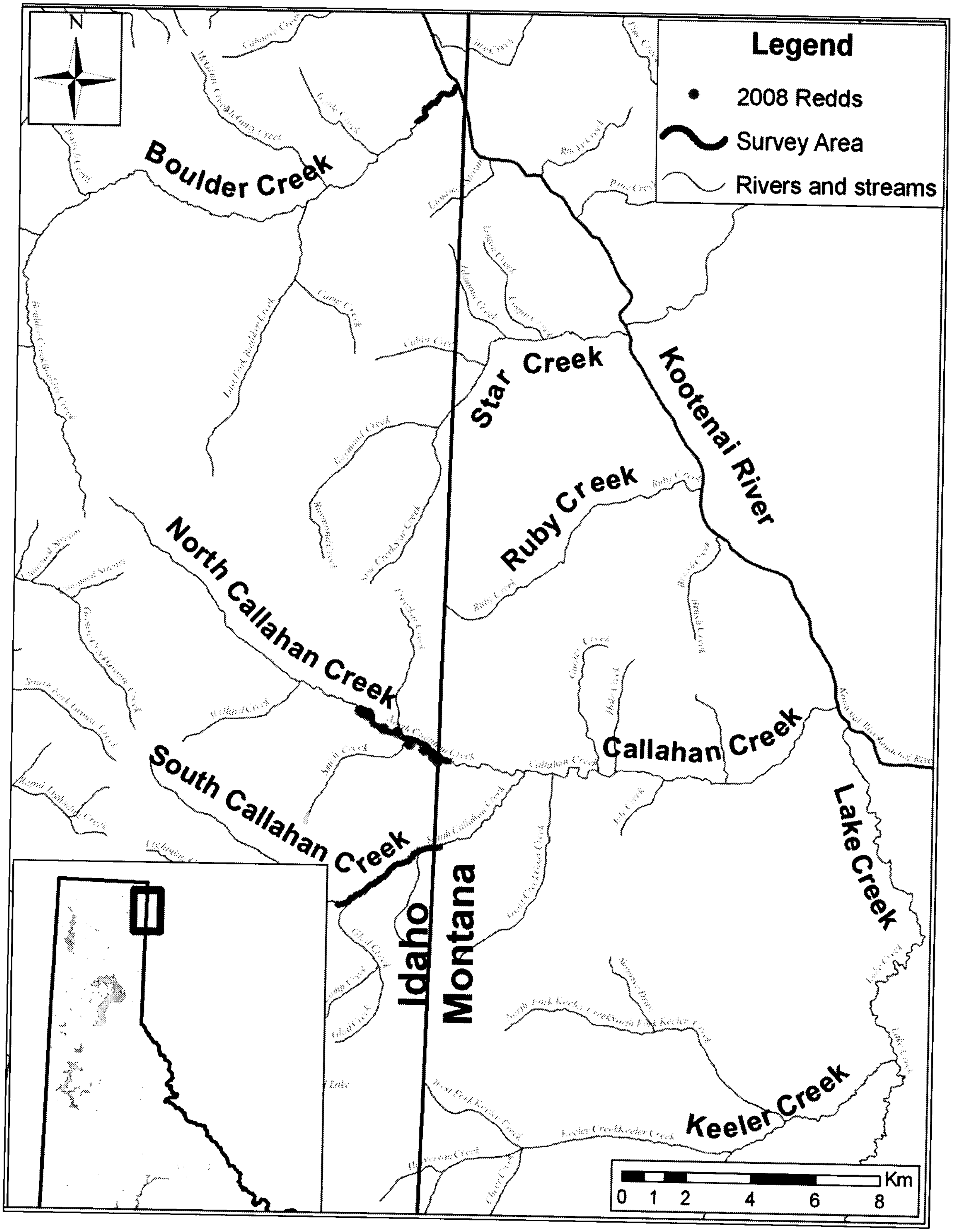


Figure 59. Stream reaches surveyed for bull trout redds in the Kootenai River watershed, Idaho, on October 9th and 10th, 2008 and the locations of where redds were observed.

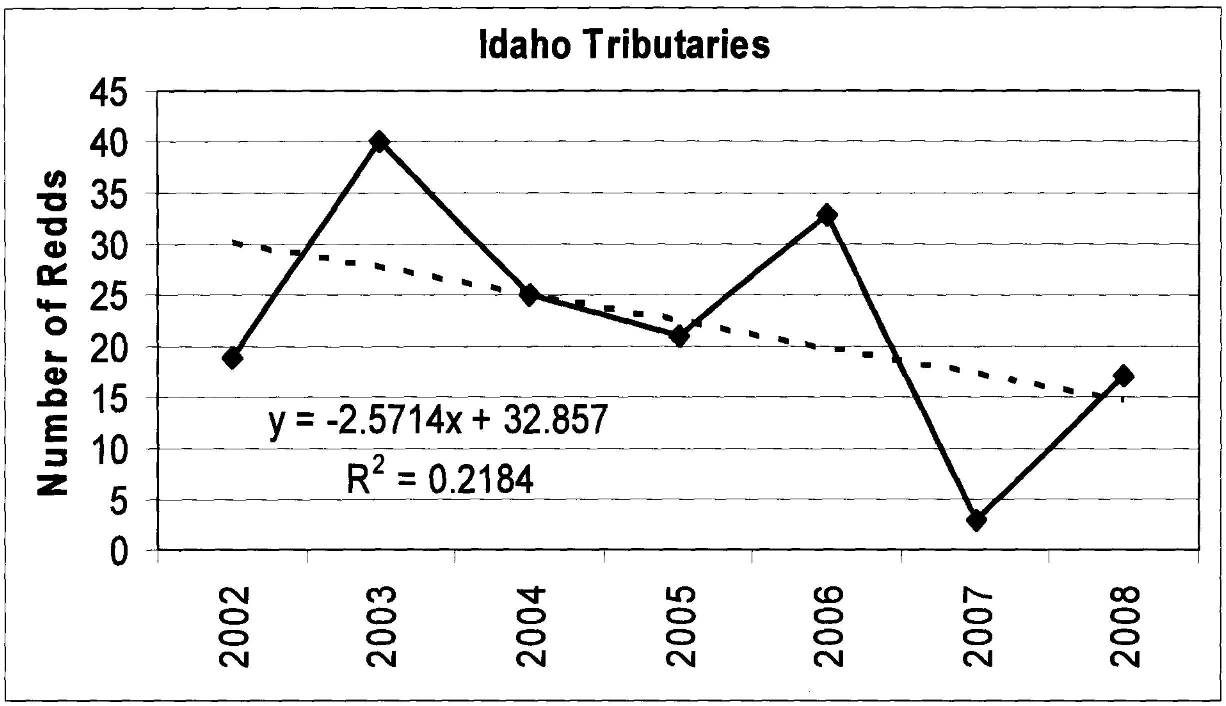
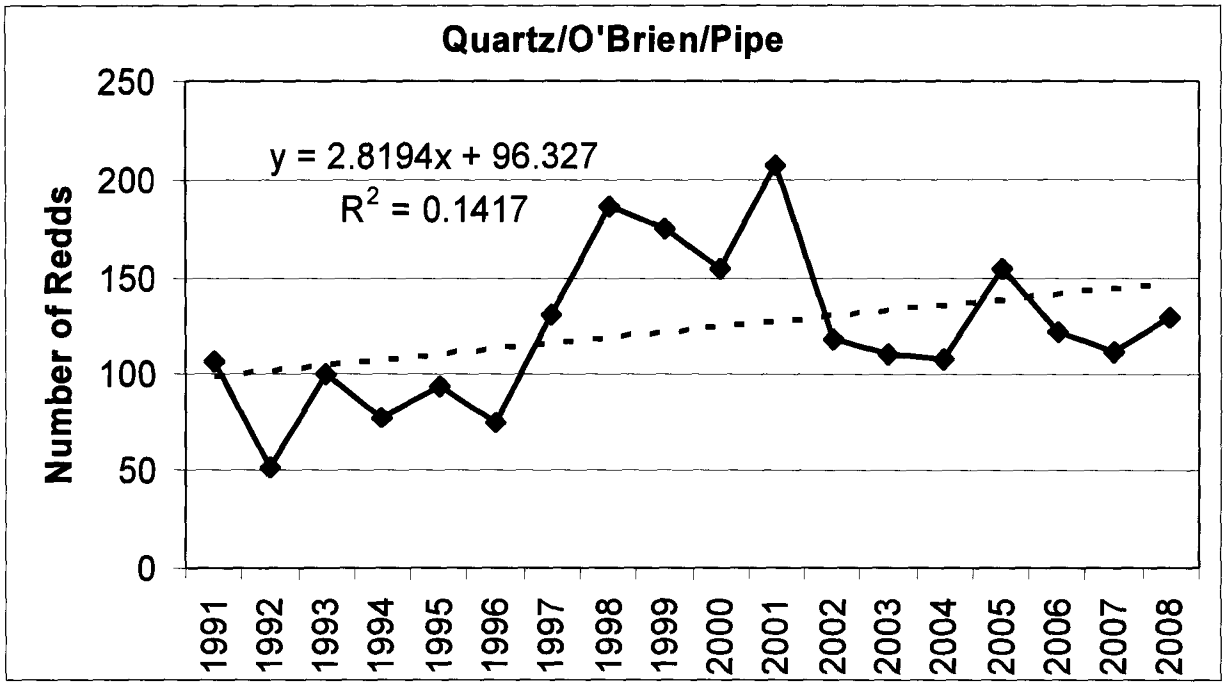


Figure 60. Linear regressions depicting trends in bull trout redd counts in tributaries in the Idaho section of the Kootenai River Core Area from 2002 to 2008.



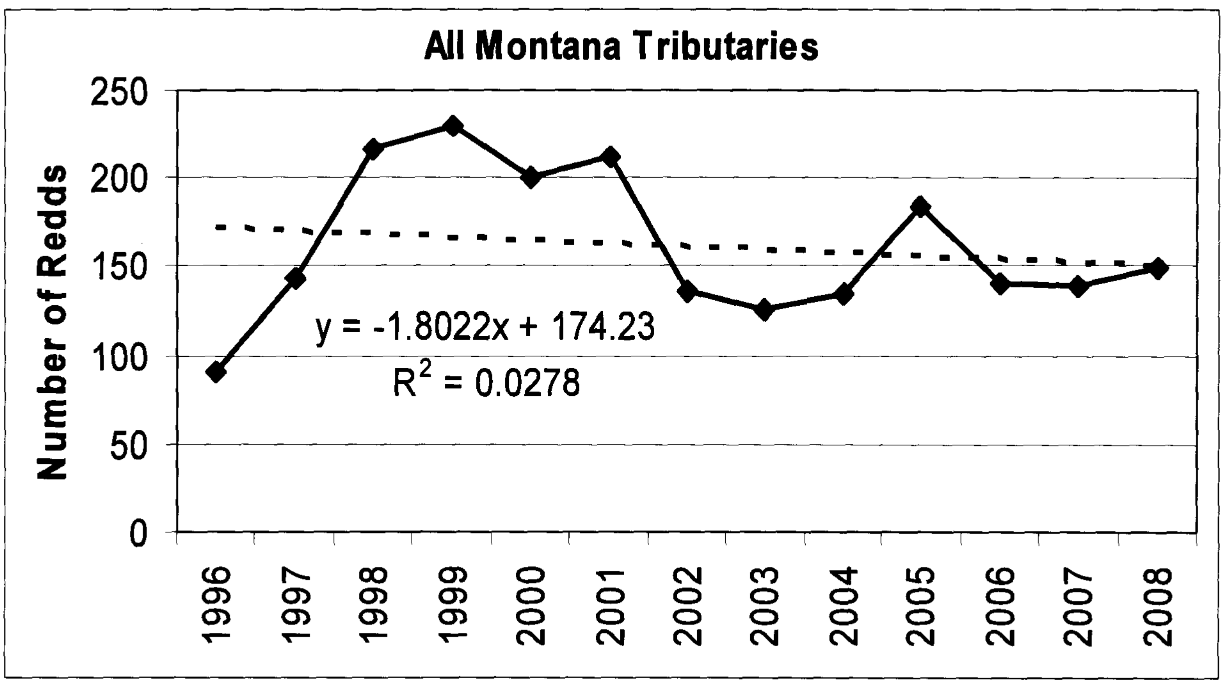


Figure 61. Linear regressions depicting trends in bull trout redd counts in select tributaries (Quartz, O'Brien, and Pipe Creeks) and all tributaries in the Montana section of the Kootenai River Core Area.

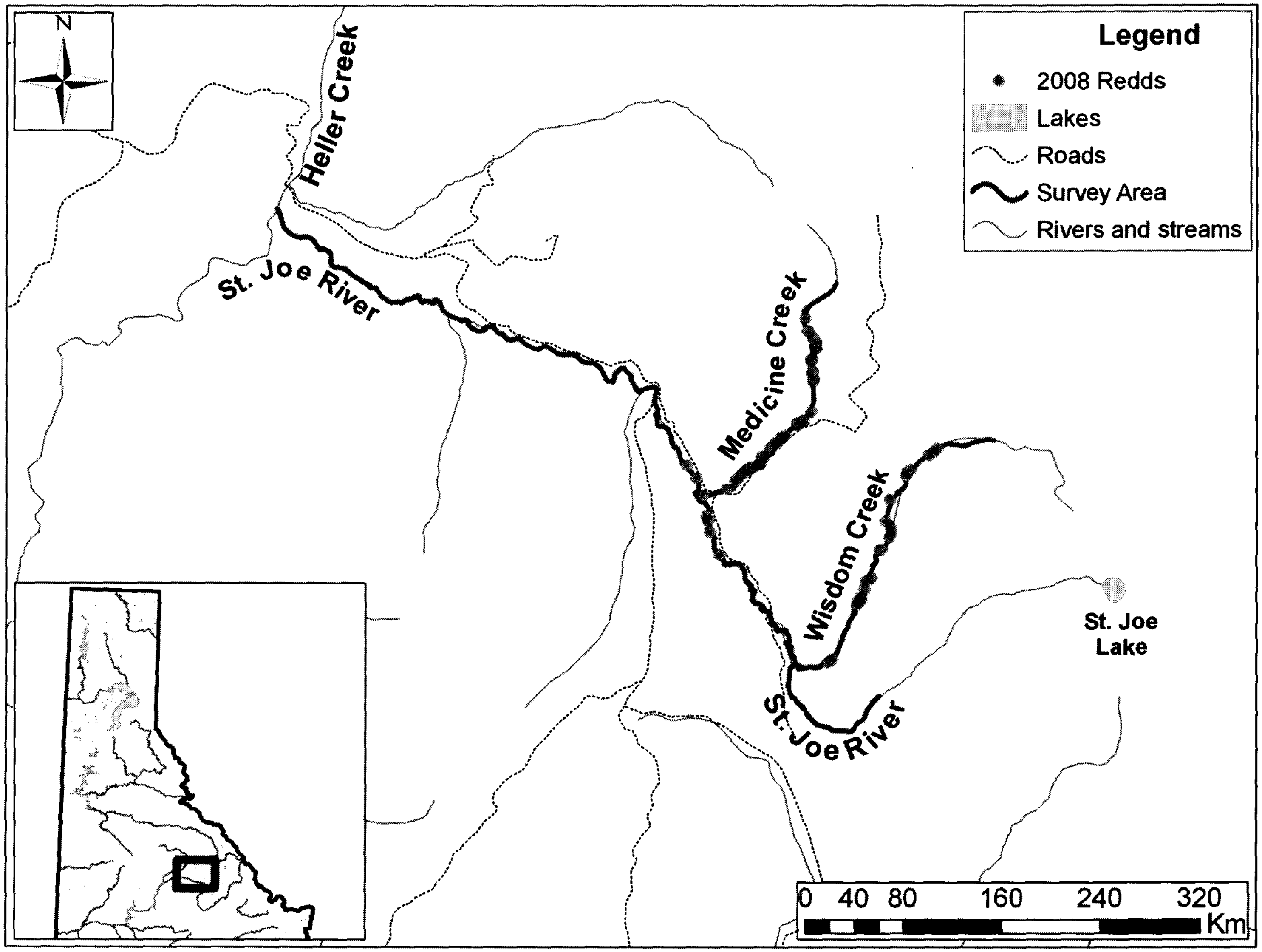


Figure 62. Stream reaches surveyed for bull trout redds in the St. Joe River basin, Idaho, on September 24, 2008 and the locations where redds were observed.

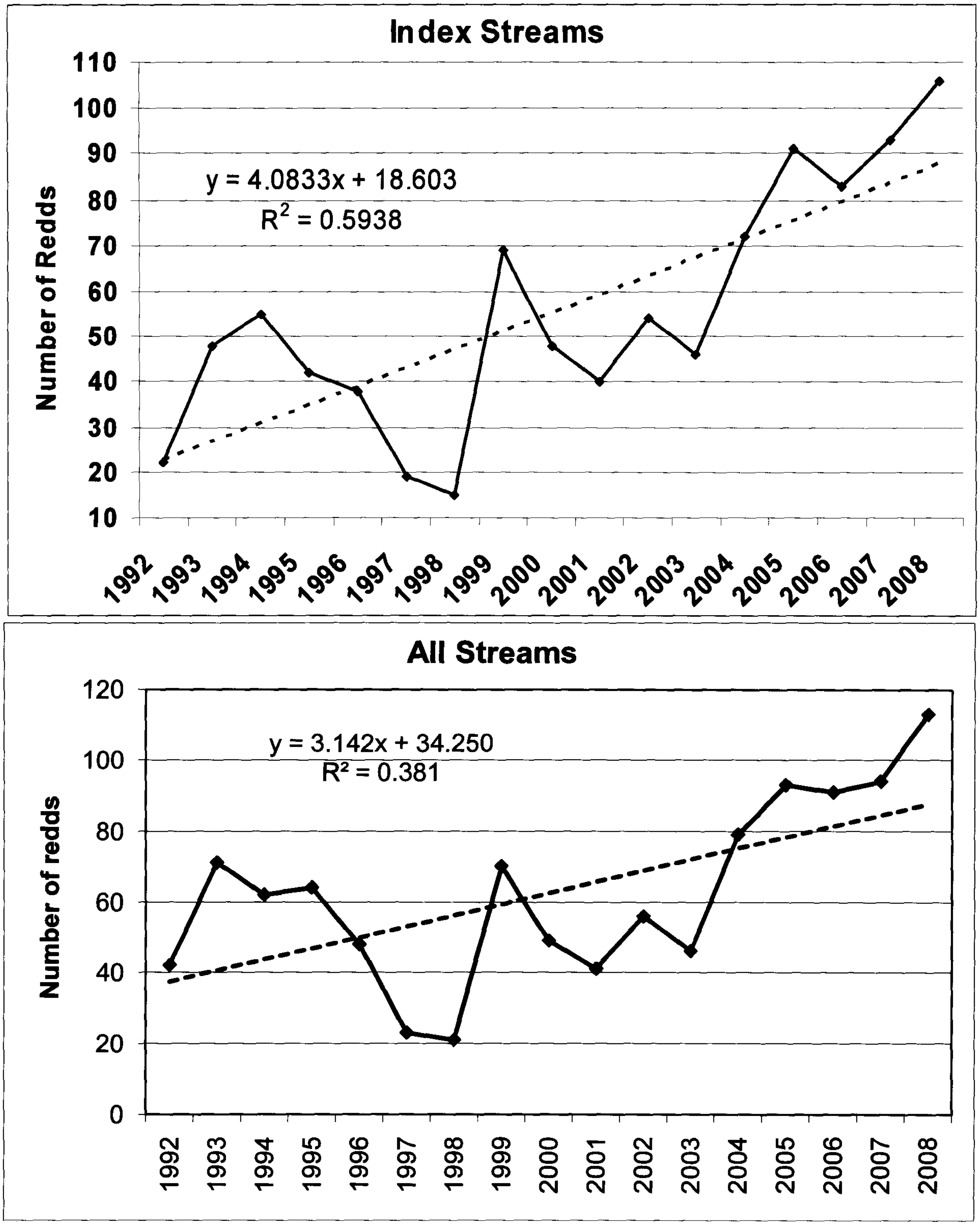


Figure 63. Linear regressions depicting trends in bull trout redd counts (three index streams and all streams combined) in the St. Joe River section of the Coeur d'Alene Lake Core Area, Idaho, from 1992 to 2008.

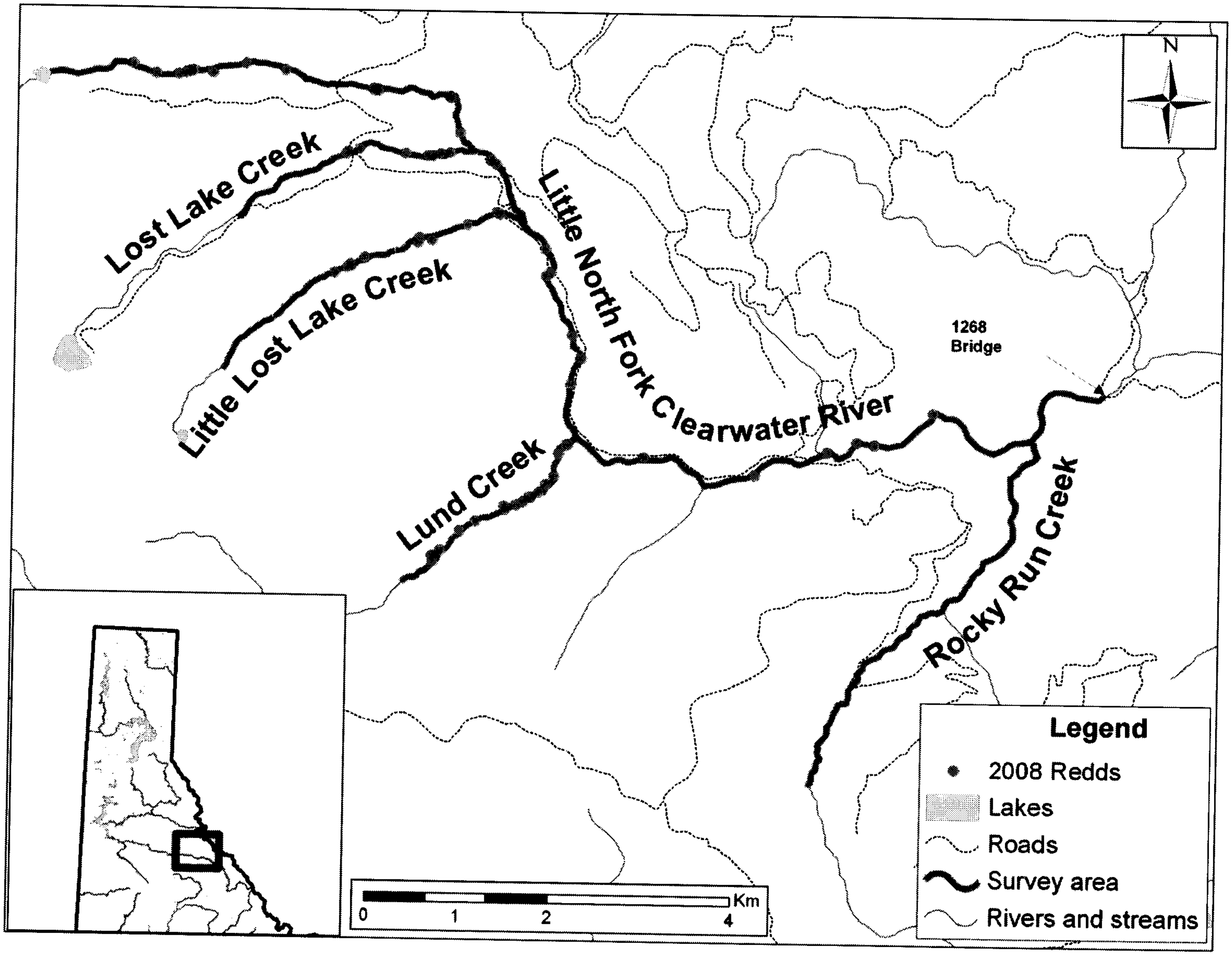


Figure 64. Stream reaches surveyed for bull trout redds in the Little North Fork Clearwater River basin, Idaho, on September 25, 2008 and the locations where redds were observed.

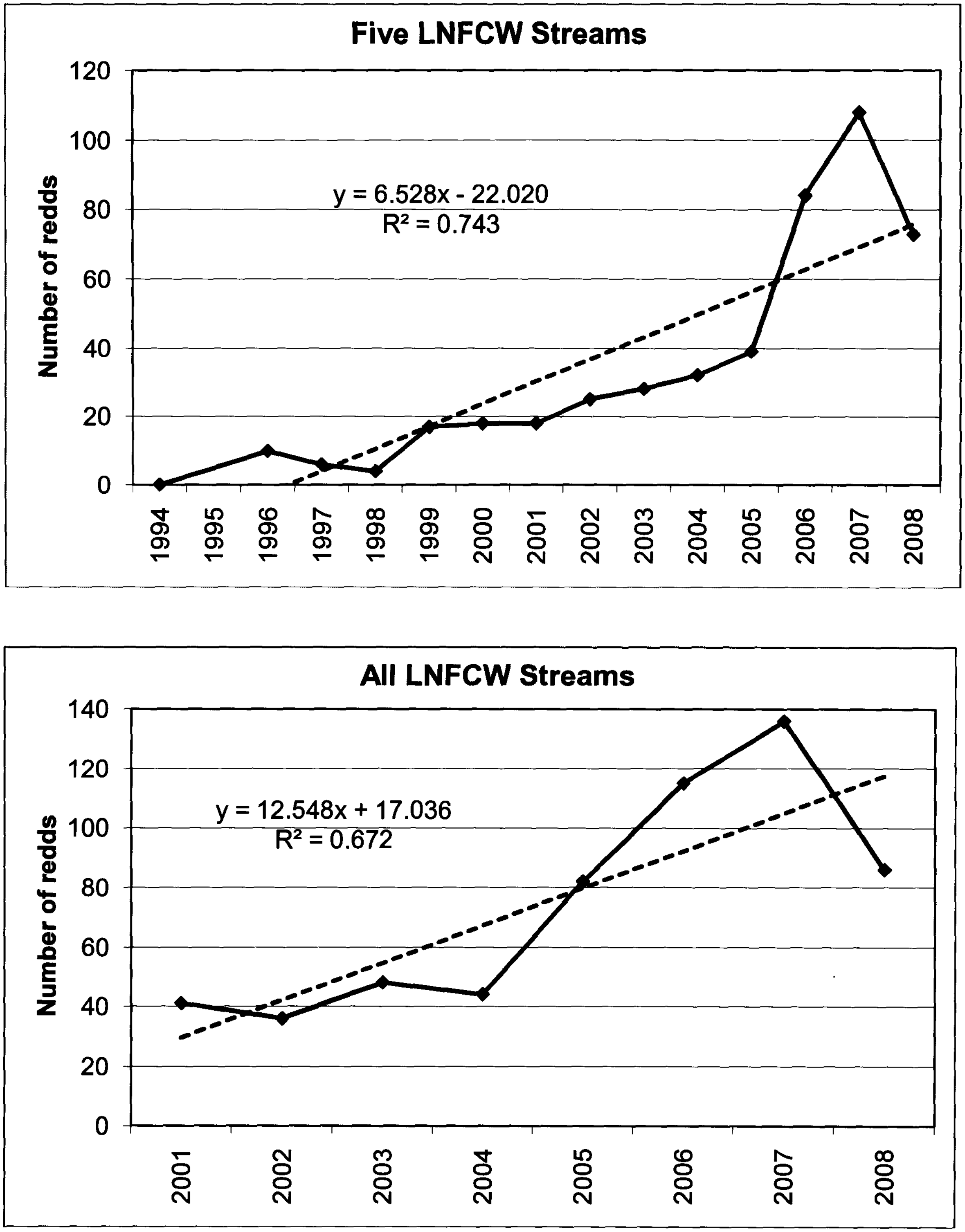
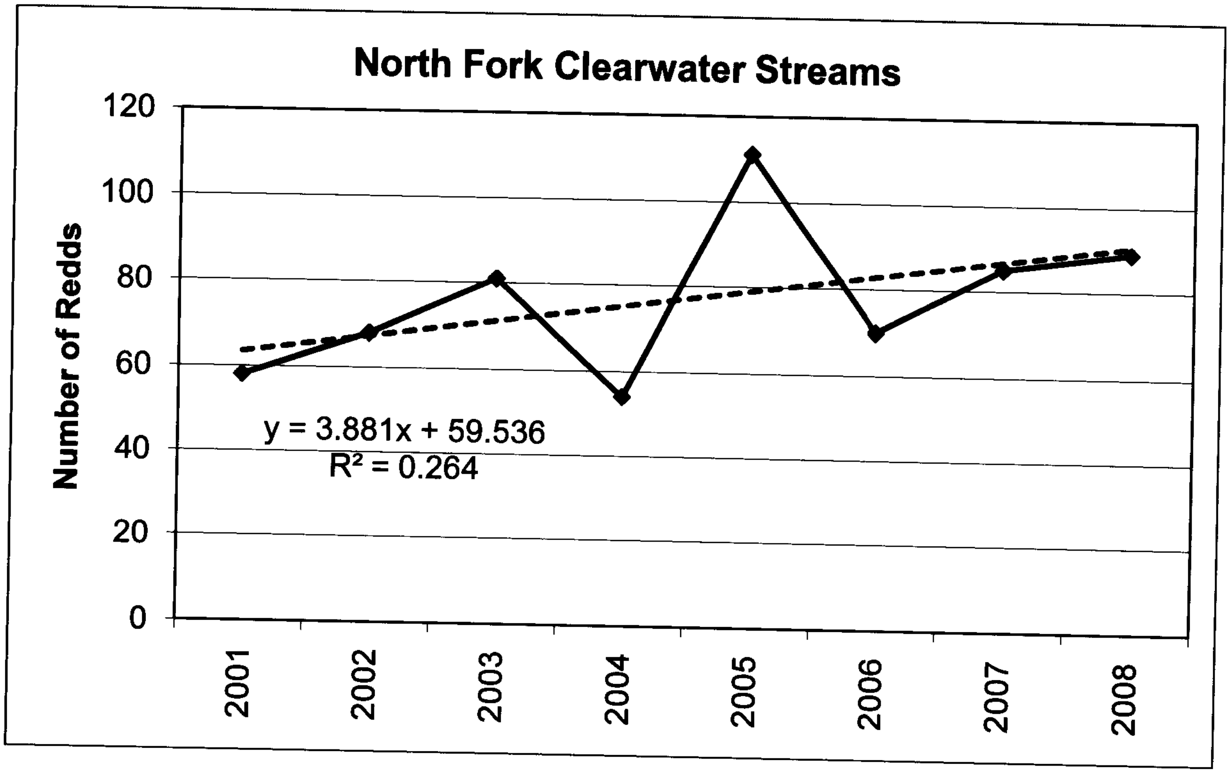


Figure 65. Linear regressions depicting trends in bull trout redd counts (five consistently counted streams and all streams combined) over time in the Little North Fork Clearwater River basin, Idaho.



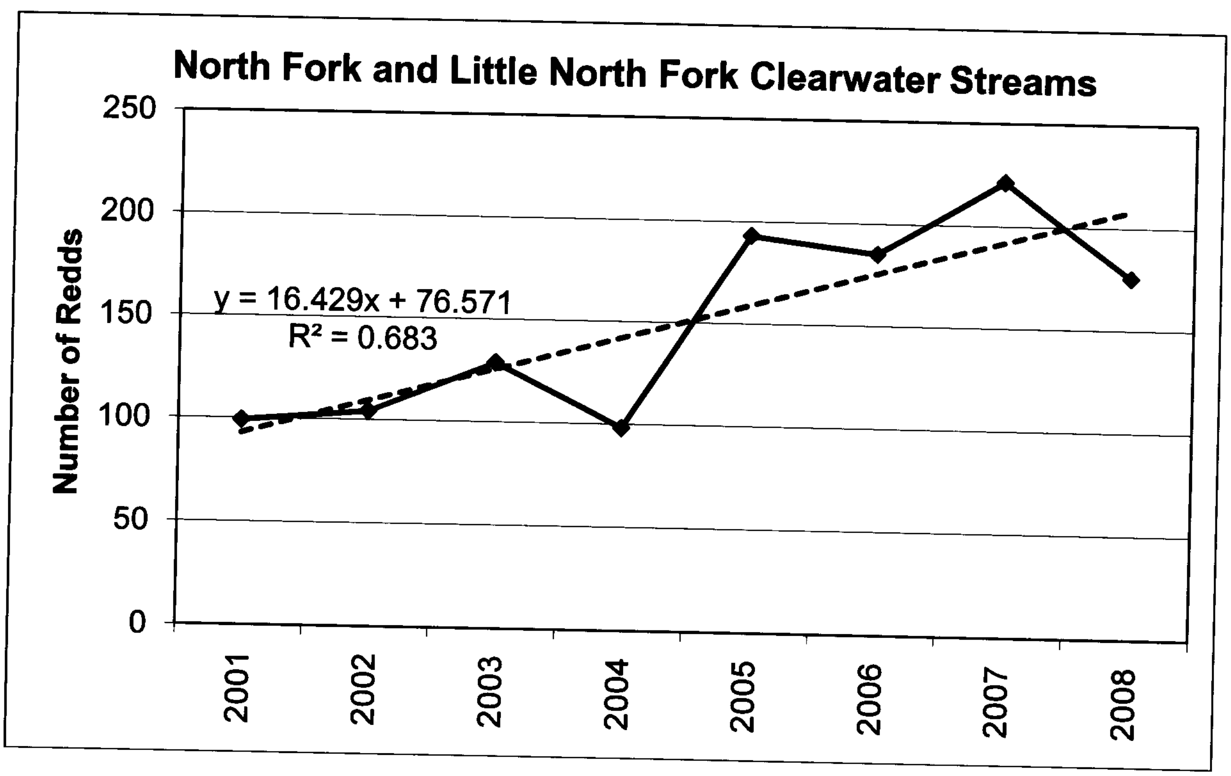


Figure 66. Linear regressions depicting trends in bull trout redd counts from 2001 to 2008 in the North Fork Clearwater River and the Little North Fork Clearwater River, Idaho, combined.

Table 12. Abundance criteria required before bull trout can be considered as recovered in the following basins of Northern Idaho (USFWS 2002).

Core Area	Recovery Criteria		
	Minimum number local of populations with more than 100 adults	Minimum number of adults in the entire core area.	Trend in abundance
Priest Lake basin	5	1,000	Stable or Increasing
Pend Oreille Lake basin	6	2,500	Stable or Increasing
Kootenai River basin [A]	5	1,000	Stable or Increasing
Coeur d'Alene Lake basin	NA	1,100 [B]	Stable or Increasing
North Fork Clearwater River basin [C]	11 (> 100 adults not required)	5,000	Stable or Increasing

[A] Core area includes tributaries in Idaho and Montana.

[B] This value is the desired annual spawning escapement - not the total number of adults in the core area. At least 800 must occur in the St. Joe River watershed (300 must occur downstream of Red Ives Creek) and 300 in the Coeur d'Alene River watershed.

[C] Only the Little North Fork Clearwater River, a tributary of the North Fork Clearwater River basin, is located in the Panhandle Region.

Table 13. Description of bull trout redd count transect locations, distance surveyed and number of redds counted in the Priest Lake basin, Idaho, from 1985 to 2008

Stream	Transect Description	Length (km)	1985	1986	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Upper Priest River	Falls to Rock Cr.	12.5	--	--	--	--	--	--	15	4	15	33	7	7	17	8	5	13	21	5	14
	Rock Cr. to Lime Cr.	1.6	--	--	--	2	1	1	2	0	3	7	0	2	0	0	0	0	1	0	0
	Lime Cr. to Snow Cr.	4.2	12[a]	5[a]	--	3	4	2	8	1	10	9	9	5	1	16	12	3	4	1	5
	Snow Cr. to Hughes	11.0	--	--	--	0	0	--	0	3	7	4	2	8	3	13	2	10	0	1	2
	Hughes Cr. to Priest	2.3	--	--	--	0	0	--	0	--	--	0	0	--	--	--	--	--	--	--	--
Rock Cr.	Mouth to F.S. trail	0.8	--	--	0	0	--	--	2	1	0	--	0	0	0	--	1	0	0	0	0
Lime Cr.	Mouth upstream 1.2	1.2	4[b]	1[b]	0	0	--	--	0	2	0	1	0	0	0	0	0	0	0	0	0
Cedar Cr.	Mouth upstream 3.4	3.4	--	1	--	0	2	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Ruby Cr.	Mouth to waterfall	3.4	--	--	0	0	--	--	--	0	0	--	--	--	0	--	--	0	--	0	0
Hughes Cr.	Trail 311 to trail 312	2.5	1	17	7	3	2	0	1	4	0	1	0	0	0	1	0	0	0	0	0
	F.S. road 622 to	4.0	35[c]	2[c]	2	0	7	1	2	0	0	0	0	0	0	1	2	1	1	0	0
	F.S. road 622 to	7.1	4[d]	0[d]	--	1	--	--	2	3	1	0	2	6	1	0	1	1	1	0	0
Bench Cr.	Mouth upstream 1.1	1.1	1	2	0	2	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Jackson Cr.	Mouth to F.S. trail	1.8	--	--	4	0	0	0	0	0	0	--	--	--	0	0	0	0	1	0	0
Gold Cr.	Mouth to Culvert	3.7	24	23	5	2	6	5	3	0	1	1	9	5	2	2	0	1	0	0	1
Boulder Cr.	Mouth to waterfall	2.3	--	--	0	0	0	--	0	0	0	--	0	--	--	--	--	0	--	0	0
Trapper Cr.	Mouth upstream 5.0	5.0	--	--	--	4	4	2	5	3	8	2	0	1	0	0	0	0	--	0	0
Caribou Cr.	Mouth to old road	2.6	--	--	--	1	0	0	0	0	0	--	--	--	--	--	--	--	--	--	--
All stream reaches combined		70.5	80[e]	50[e]	18	18	28	12[f]	41	22	45	58	29	34	24	41	23	29	29	7	22
Only those stream reaches counted		23.8[g]	80	50	14[h]	11	21[h]	8[f]	17	10	12	12	20	16	4	20	15	6	6	1	6

[a] Redds were counted from Lime Creek to Cedar Creek, which is about 1/2 the distance that is currently counted.
[b] Redds were counted from the mouth to FS road 1013, which is about 1/4 of the distance that is currently counted.
[c] About 2/3 of the distance was counted in 1985 and 1986 that is currently counted.
[d] Redds were counted from FS road 622 to the FS Road 1013, which is about 1/3 of the distance that is currently counted.
[e] Redds were counted in about 1/5 of the stream reaches where they are currently counted.
[f] During 1985 and 1986 about 15 km of stream was counted.
[g] Two of the stream reaches were not counted.
[h] Observation conditions were impaired by high runoff.

Table 14. Statistics for the linear regression of bull trout redds counted in different watershed in bull trout recovery core areas included in the Idaho Panhandle Region during 2008.

Streams/Core Area	Years evaluated	No. of observations	R value	R square	P value	Slope (Redd Coefficient)	Redd Standard Error
Upper Priest - 1985 sites	1985-2008	16	0.82	0.66	0.00	-2.39	0.45
Upper Priest - all streams	1996-2008	13	0.57	0.33	0.04	-1.90	0.82
Kootenai River - Idaho streams	2002-2008	7	0.47	0.22	0.29	-2.57	2.18
Kootenai River - three MT streams	1990-2008	19	0.43	0.18	0.07	3.05	1.56
Kootenai River - all MT streams	1996-2008	13	0.17	0.03	0.59	-1.80	3.22
Pend Oreille - index streams	1983-2008	24	0.08	0.01	0.70	1.14	2.94
Pend Oreille - index streams	1992-2008	16	0.28	0.08	0.29	6.70	6.07
Pend Oreille - all streams	1983-2008	20	0.15	0.02	0.54	3.43	5.45
Pend Oreille - all streams	1992-2008	16	0.55	0.30	0.03	20.54	8.42
Lightning Creek - all tribs	1992-2008	16	0.50	0.25	0.05	3.81	1.75
St Joe River - index streams	1992-2008	17	0.77	0.59	0.00	4.08	0.87
St Joe River - all streams	1992-2008	17	0.62	0.38	0.01	3.14	1.03
LNF Clearwater - five streams	1994-2008	14	0.86	0.74	0.00	6.53	1.11
LNF Clearwater - all streams	2001-2008	8	0.82	0.67	0.01	12.55	3.58
NF Clearwater - all streams	2001-2008	8	0.51	0.26	0.19	3.88	2.65
NF and LNF Clearwater	2001-2008	8	0.83	0.68	0.01	16.43	4.57

Table 15. Number of bull trout redds counted per stream in the Pend Oreille Lake, Idaho, Core Area, from 1983 to 2008.

Stream	1983[a]	1984	1985	1986[b]	1987[c]	1988	1989	1990	1991[d]	1992	1993	1994	1995[e]	1996	1997	1998	1999	2000[f]	2001[f,g]	2002[g]	2003[h]	2004	2005	2006[i]	2007[j]	2008[L]
CLARK FORK R.	--	--	--	--	--	--	--	--	--	2	8	17	18	3	7	8	5	5	6	7	8	1	--	3	2	0
Lightning Cr.	28	9	46	14	4	--	--	--	--	11	2	5	0	6	0	3	16	4	7	8	8	9	22	9	3	10
East Fork	110	24	132	8	59	79	100	29	--	32	27	28	3	49	22	64	44	54	36	58	38	77	50	51	34	38
Savage Cr.	36	12	29	--	0	--	--	--	--	1	6	6	0	0	0	0	4	2	4	15	7	15	7	25	0	8
Char Cr.	18	9	11	0	2	--	--	--	--	9	37	13	2	14	1	16	17	11	2	8	7	14	15	20	1	5
Porcupine Cr.	37	52	32	1	9	--	--	--	--	4	6	1	2	0	0	0	4	4	0	0	5	10	14	8	8	8
Wellington Cr.	21	18	15	7	2	--	--	--	--	9	4	9	1	5	2	1	22	8	7	7	8	7	6	29	9	10
Rattle Cr.	51	32	21	10	35	--	--	--	--	10	8	0	1	10	2	15	13	12	67	33	37	34	34	21	2	24
Johnson Cr.	13	33	23	36	10	4	17	33	25	16	23	3	4	5	27	17	31	4	34	31	0	32	45	28	32	40
Twin Cr.	7	25	5	28	0	--	--	--	--	3	4	0	5	16	6	10	19	10	1	8	3	6	7	11	0	4
Morris Cr.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	1	0	7	1	1	3	16	0	6
Strong Creek	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	--	--	--	--	0	--	0	--	--	--	7
NORTH SHORE																										
Trestle Cr.	298	272	298	147	230	236	217	274	220	134	304	276	140	243	221	330	253	301	335	333	361	102	174	395	145	183
Pack River	34	37	49	25	14	--	--	--	--	65	21	22	0	6	4	17	0	8	28	22	24	31	53	44	16	11
Grouse Cr.	2	108	55	13	56	24	50	48	33	17	23	18	0	50	8	44	50	77	18	42	45	28	77	55	38	31
EAST SHORE																										
Granite Cr.	3	81	37	37	30	--	--	--	--	0	7	11	9	47	90	49	41	25	7	57	101	149	132	166	104	52
Sullivan Springs	9	8	14	--	6	--	--	--	--	0	24	31	9	15	42	10	22	19	8	15	12	14	15	28	17	7
North Gold Cr.	16	37	52	8	36	24	37	35	41	41	32	27	31	39	19	22	16	19	16	24	21	56	34	30	28	17
Gold Cr.	131	124	111	78	62	111	122	84	104	93	120	164	95	100	76	120	147	168	127	203	126	167	200	235	179	73
West Gold Cr.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4	0	7
PRIEST RIVER																										
M.F. East River	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4	8	21	20	48	71	34	36
Uleda Creek	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	4	3	7	4	7	2	7
N.F. East River	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	0	0	--	0
Total 6 index streams[k]	570	598	671	290	453	478	543	503	423	333	529	516	273	486	373	597	541	623	566	691	591	462	580	794	456	382
Total of all streams	814	881	930	412	555	478	543	503	423	447	656	631	320	610	527	726	705	732	710	890	836	781	940	1256	654	584
Lightning Cr.-Total	301	156	286	40	111	79	100	29	0	76	90	62	9	84	27	99	120	95	123	129	110	166	148	163	57	103

[a] Incomplete surveys occurred on Porcupine and Grouse creeks.
[b] Incomplete surveys occurred on Grouse, Rattle, and East Fork Lightning creeks.
[c] Incomplete surveys occurred on Granite Creek.
[d] Early snow fall prevented counts in many streams (East Fork of Lightning Creek was not included in index counts).
[e] Observations were impaired by high runoff in all streams except Sullivan Spings, N. Gold and S. Gold creeks, and the Clark Fork River.
[f] A headcut barrier prevented access to most spawning areas on Johnson creek in 2000, and also potentially on Granite Creek in 2001.
[g] Incomplete surveys occurred on M.F. East River.
[h] Observation were impaired by high runoff in Trestle Creek.
[i] Large early spawning kokanee made it difficult to distinguish bull trout redds from kokanee redds in Sullivan Springs.
[j] Observation impaired by high water in Uleda and Savage creeks.
[k] Index streams include Trestle, East Fork Lightning, Gold, North Gold, Johnson, and Grouse creeks.

Table 16. The estimated number of adult bull trout associated with each tributary where redds were counted in the Pend Oreille Lake, Idaho, Core Area from 1983 to 2008. Stream counts shaded in gray indicate when over 100 adults were associated with it. Total counts shaded in gray indicate when the entire population exceeded 2,500 fish.

Stream	1983[a]	1984	1985	1986[b]	1987[c]	1988	1989	1990	1991[d]	1992	1993	1994	1995[e]	1996	1997	1998	1999	2000[f]	2001[f,g]	2002[g]	2003[h]	2004	2005	2006[i]	2007[j]	2008[L]
CLARK FORK R.	–	–	–	–	–	–	–	–	–	6	26	54	58	10	22	26	16	16	19	22	26	3	–	10	6	0
Lightning Cr.	90	29	147	45	13	–	–	–	–	35	6	16	0	19	0	10	51	13	22	26	26	29	70	29	10	32
East Fork	352	77	422	26	189	253	320	93	–	102	86	90	10	157	70	205	141	173	115	186	122	246	160	163	109	122
Savage Cr.	115	38	93	–	0	–	–	–	–	3	19	19	0	0	0	0	13	6	13	48	22	48	22	80	0	26
Char Cr.	58	29	35	0	6	–	–	–	–	29	118	42	6	45	3	51	54	35	6	26	22	45	48	64	3	16
Porcupine Cr.	118	166	102	3	29	–	–	–	–	13	19	3	6	0	0	0	13	13	0	0	16	32	45	26	26	26
Wellington Cr.	67	58	48	22	6	–	–	–	–	29	13	29	3	16	6	3	70	26	22	22	26	22	19	93	29	32
Rattle Cr.	163	102	67	32	112	–	–	–	–	32	26	0	3	32	6	48	42	38	214	106	118	109	109	67	6	77
Johnson Cr.	42	106	74	115	32	13	54	106	80	51	74	10	13	16	86	54	99	13	109	99	0	102	144	90	102	128
Twin Cr.	22	80	16	90	0	–	–	–	–	10	13	0	16	51	19	32	61	32	3	26	10	19	22	35	0	13
Morris Cr.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	3	0	22	3	3	10	51	0	19
Strong Creek	–	–	–	–	–	–	–	–	–	–	–	–	–	6	–	–	–	–	–	0	–	0	–	–	–	22
NORTH SHORE																										0
Trestle Cr.	954	870	954	470	736	755	694	877	704	429	973	883	448	778	707	1056	810	963	1072	1066	1155	326	557	1264	464	586
Pack River	109	118	157	80	45	–	–	–	–	208	67	70	0	19	13	54	0	26	90	70	77	99	170	141	51	35
Grouse Cr.	6	346	176	42	179	77	160	154	106	54	74	58	0	160	26	141	160	246	58	134	144	90	246	176	122	99
EAST SHORE																										0
Granite Cr.	10	259	118	118	96	–	–	–	–	0	22	35	29	150	288	157	131	80	22	182	323	477	422	531	333	166
Sullivan Springs	26	23	41	–	19	–	–	–	–	0	77	99	29	48	134	32	70	61	26	48	38	45	48	90	54	22
North Gold Cr.	51	118	166	26	115	77	118	112	131	131	102	86	99	125	61	70	51	61	51	77	67	179	109	96	90	54
Gold Cr.	419	397	355	250	198	355	390	269	333	298	384	525	304	320	243	384	470	538	406	650	403	534	640	752	573	234
West Gold Cr.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	13	0	22
PRIEST RIVER																										0
M.F. East River	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	13	26	67	64	154	227	109	115
Uleda Creek	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	10	13	10	22	13	22	6	22
N.F. East River	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	0	0	–	0
Trap and Transport	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	35	35	35	40	29	19	25	–
Total 6 index streams[k]	1824	1914	2147	928	1450	1530	1738	1610	1354	1066	1693	1651	874	1555	1194	1910	1731	1994	1811	2211	1891	1478	1856	2541	1459	1222
Total of all streams	2602	2817	2972	1318	1776	1530	1738	1610	1354	1430	2099	2019	1024	1951	1686	2323	2256	2342	2307	2883	2710	2539	3037	4038	2118	1869
Lightning Cr.-Total	873	452	829	116	322	229	290	84	0	220	261	180	26	244	78	287	348	276	357	374	319	481	429	522	182	330

Table 17. The number of bull trout redds counted per stream in the Idaho and Montana sections of the Kootenai River Core Area from 1990 to 2008.

Stream	Length (km)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
IDAHO																				
North Callahan Creek	3.3	--	--	--	--	--	--	--	--	--	--	--	--	13	30	17	12	29	3	17
South Callahan Creek	4.3	--	--	--	--	--	--	--	--	--	--	--	--	4	10	8	8	4	0	0
Boulder Creek	1.8	--	--	--	--	--	--	--	--	--	--	--	2	2	0	0	1	0	--	0
MONTANA																				
Quartz Creek	16.1	76	77	17	89	64	67	47	69	105	102	91	154	62[d]	55	49	71	51	35	46
O'Brien Creek	6.9	--	25	24	6	7	22	12	36	47	37	34	47	45	46	51	81	65	77	79
Pipe Creek	12.9	6	5	11	6	7	5	17	26	34	36	30	6[a]	11	10	8	2	6	0	4
Bear Creek	6.9	--	--	--	--	--	6	10	13	22	36[b]	23	4[c]	17	14	6	3	14	9	14
West Fisher Creek	16.1	--	--	--	2	0	3	4	0	8	18	23	1	1	1	21	27	4	18	6
Idaho Total	9.4	0	0	0	0	0	0	0	0	0	0	0	2	19	40	25	21	33	3	17
Montana Total	58.9	82	107	52	103	78	103	90	144	216	229	201	212	136	126	135	184	140	139	149
Quartz/O'Brien/Pipe	35.9	82	107	52	101	78	94	76	131	186	175	155	207	118	111	108	154	122	112	129
Total all streams	68.3	82	107	52	103	78	103	90	144	216	229	201	214	155	166	160	205	173	142	166

[a] A human built dam (stacked up cobble) was constructed downstream of the traditional spawning area.

[b] This count includes redds constructed by resident and migratory fish.

[c] Libby Creek was dewatered at the Highway 2 bridge, downstream of Bear Creek spawning sites, during the bull trout spawning run.

[d] A log jam may have been a partial barrier.

Table 18. The number of bull trout redds counted by stream in the St. Joe River basin, Idaho, from 1992 to 2008. The Idaho Department of Fish and Game has counted the index streams since 1995. All other stream reaches were counted by the U.S. Forest Service and/or volunteers.

Stream Name	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Aspen Cr.	–	–	–	–	–	–	–	–	–	–	0	–	–	–	–	–	–
Bacon Cr.	0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bad Bear Cr.	–	0	0	–	–	–	–	–	–	–	–	0	–	–	–	–	–
Bean Cr.	14	–	–	0	–	–	–	–	–	–	–	–	–	–	–	–	–
Beaver Cr.	2	2	0	0	0	0	1	0	–	0	0	0	0	0	0	0	0
Bluff Cr.- East Fork	0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
California Cr.	2	4	0	2	3	0	–	–	0	0	0	0	0	0	0	0	0
Copper Cr.	–	–	0	–	0	–	–	–	–	–	0	0	0	–	–	0	0
Entente Cr.	–	–	–	–	–	–	–	0	–	–	1	0	–	–	–	–	–
Fly Cr.	1	–	–	0	0	0	2	0	–	–	1	0	0	0	–	0	2
Gold Cr. Lower mile	–	0	–	–	–	0	–	0	–	–	–	0	–	–	–	–	–
Gold Cr. Midde	–	–	–	0	–	–	–	0	–	–	–	–	–	–	–	–	–
Gold Cr. Upper	–	2	–	–	1	1	0	–	–	–	–	–	–	–	–	–	–
Gold Cr. All	–	–	–	–	–	–	–	–	–	1	0	–	0	–	–	–	–
Heller Cr.	0	0	0	0	–	1	0	0	0	–	0	0	7	1	5	0	0
Indian Cr.	0	0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Medicine Cr.	11	33	48	17[a]	23[a]	13[a]	11[a]	48[a]	43	16	42	28	52	62	71	55	71
Mosquito Cr.	0	–	0	0	4	0	2	–	–	–	–	–	0	0	–	–	–
Quartz Cr.	–	–	–	–	–	–	–	–	–	–	0	–	–	–	–	–	–
Red Ives Cr.	–	0	1	1	0	1	0	0	0	0	0	0	0	1	0	1	1
Ruby Cr.	0	1	–	8	–	–	–	–	–	–	–	–	–	–	–	–	–
Sherlock Cr.	0	3	0	2	1	1	0	1	0	–	–	0	0	0	0	0	3
Simmons Cr. - Lower	–	0	0	0	–	–	–	–	–	0	–	–	–	–	–	–	1
Simmons Cr. - NF to Three Lakes	–	5	0	–	–	–	–	–	–	–	–	–	–	–	0	–	–
Simmons Cr. - Three Lakes to Rd 1278	–	3	5	5	0	0	0	0	–	–	–	–	–	–	0	–	–
Simmons Cr. - Rd 1278 to Washout	–	0	0	0	1	0	1	0	–	–	–	–	–	–	–	–	–
Simmons Cr. - Upstream of Washout	–	0	–	–	–	0	–	–	–	–	–	–	–	–	–	–	–
Simmons Cr. - East Fork	–	–	0	–	–	–	–	–	–	–	–	–	–	–	–	–	–
St. Joe River - below Tento Creek	–	–	–	–	0	–	–	–	–	–	–	–	–	–	–	–	–
St. Joe River - Spruce Tree CG to St. J. Loc	–	–	–	0	–	–	–	–	–	–	–	–	–	–	–	–	–
St. Joe River - St. Joe Lodge to Broken Leg	–	–	–	4	–	–	–	–	–	–	–	–	–	–	–	–	–
St. Joe River - Broken Leg Cr upstream	–	–	–	0	–	–	–	–	–	–	–	–	–	–	–	–	–
St. Joe River - Bean to Heller Cr.	0	0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
St. Joe River - Heller to St. Joe Lake	10[b]	14[b]	3[b]	20	14	6	0	10	2	11	3	9	9	10	0	6	8
Three Lakes Creek	–	–	–	–	0	–	–	–	–	–	–	–	–	–	–	–	–
Timber Cr.	–	0	1	0	–	–	–	–	–	–	–	–	–	–	–	–	–
Wampus cr	–	0	0	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Washout cr.	–	3	0	0	0	0	–	–	–	–	–	–	–	–	–	–	–
Wisdom Cr	1	1	4	5	1[a]	0	4	11	3	13	9	9	11	19	12	32	27
Yankee Bar	1	0	–	–	–	0	–	–	1	0	0	0	0	0	3	0	0
Total - Index Streams [c]	22	48	55	42	38	19	15	69	48	40	54	46	72	91	83	93	106
Total - All Streams	42	71	62	64	48	23	21	70	49	41	56	46	79	93	91	94	113
Number of streams counted	16	23	19	21	16	17	12	13	8	9	14	14	13	11	11	11	12

[a] These counts differed from what the U.S. Forest Service counted.

[b] These counts did not include from California Creek to Medicine Creek, a reach where bull trout spawning typically occurs.

[c] Index streams include Medicine Creek, St. Joe River from Heller Creek to St. Joe Lake, and Wisdom Creek.

Table 19. Number of bull trout redds counted per stream in the Little North Fork Clearwater River basin, Idaho, from 1994 to 2008. Numbers in parentheses are redds smaller than 300 mm in diameter.

Stream	Length (km)	1994[a]	1996	1997	1998	1999	2000	2001	2001[b]	2002	2003	2004	2005	2006	2007	2008
Buck Creek	4.8	--	--	--	--	--	--	--	--	--	5	--	--	--	--	--
Canyon Creek	5.5	--	--	--	--	--	--	--	--	--	0	--	--	--	--	--
Butte Creek	1.2	--	--	--	--	--	--	--	5	0	--	--	--	--	--	--
Rutledge Creek		--	--	--	--	--	--	--	--	--	1	1	6	0	--	--
Rocky Run Creek	1.5	--	--	--	--	--	--	--	--	5	1	3	21	13	6 (2)	--
Lund Creek	3.9	0	7	2	2	1	1	13	5	7	7 (1)	5	19	7	30	22
Little Lost Lake Creek	3.9	0	1	1	1	7	3	1	--	2 (4)	4 (3)	15 (1)	1	34 (4)	31 (5)	14
Lost Lake Creek	3.0	0	0	0	0	--	1	--	--	0	--	1	--	10	13	8
Little North Fork Clearwater River																
1268 Bridge to Lund Cr.	7.0	--	--	--	--	--	--	--	17	6	13	8	16	18	20	13
Lund Cr. to Lost Lake Cr.	3.8	--	--	3	1	9	8	3	12	5 (2)	7	5	8	16	21	9
Lost Lake Cr. to headwaters	5.4	0	2	0	0	--	5	1	--	5	5 (1)	5	11	13	8	20
Total for all streams	40.0	0	10	6	4	17	18	18	39	30 (6)	43 (5)	43 (1)	82	111 (4)	129 (7)	86

[a] Streams were surveyed between 9/16/1994 and 9/19/1994 - one week earlier than surveys in following years.
[b] These redds were counted by personnel from the Clearwater Region.

Table 20. Number of bull trout redds counted per stream in the North Fork Clearwater River and Breakfast Creek basins, Idaho, from 1994 to 2008. These streams all occur in the IDFG Clearwater Region and were counted by personnel from the Clearwater Region or U.S. Forest Service.

Stream Survey	Length (km)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
North Fork Clearwater River		--	--	--	--	--	--	--	--	0	--	--	--	--	--	--
Black Canyon		--	--	--	--	--	--	--	--	1	--	--	--	--	--	--
Bostonia Creek		0	0	0	0	0	4	1	1	1	18	12	15	14	26	13
Boundary Creek		--	--	--	--	--	--	--	--	--	2	3	10	--	--	--
Collins Creek		--	--	--	--	--	--	--	0	--	--	--	--	--	--	--
Goose Creek		--	--	--	--	--	--		1	0	2	1	12	8	1	0
Hidden Creek		--	--	--	--	--	--	--	--	1	0	--	--	--	--	--
Isabella Creek		--	--	--	--	--	--	--	--	1	1	0	0	--	1	1
Kelley Creek - North Fork		--	--	--	--	--	--	--	14	--	--	--	--	--	--	--
Lake Creek		--	--	--	--	--	--	19	7	20	14	5	2	5	3	0
Little Moose Creek		--	--	--	--	--	--	--	0	--	--	--	--	--	--	--
Long Creek		--	--	--	--	--	--			5	0	8	10	1	6	10
Moose Creek		--	--	--	--	--	--	0	0	0	0		0	0	0	0
Niagra Gulch		--	--	--	--	--	--	2	5	6	10	3	4	2	2	2
Orogrande Creek		--	--	--	--	--	--	--	--	--	--	--	0	--	--	--
Osier Creek		--	--	--	--	--	--	3	0	2	0	--	--	--	--	--
Placer Creek		3	1	2	2	2	7	4	2	4	6	2	3	5	2	3
Pollock Creek		--	--	--	--	--	--	--	--	--	1	--	--	--	--	--
Quartz Creek		--	--	--	--	--	--	--	4	0	0	0	0	--	--	8
Ruby Creek		--	--	--	--	--	0	0	--	--	--	--	--	--	--	--
Skull Creek		--	--	--	--	--	--	--	--	0	6	5	3	--	4	9
Slate Creek		--	--	--	--	--	--	--	--	--	--	--	3	--	--	--
Swamp Creek		--	--	--	--	--	--	2	0	1	0	0	2	--	1	--
Upper NF		--	--	--	--	--	--	--	--	--	7	3	6	--	--	--
Vanderbilt Gulch		--	--	--	--	--	--		24	18	13	12	41	35	39	43
Weitas Creek		--	--	--	--	--	--	1	--	--	--	--	--	--	--	--
Windy Creek		--	--	--	--	--	2	--	--	--	--	--	--	--	--	--
Breakfast Creek																
Floodwood Creek		--	--	--	--	--	--	--	--	4	0	0	--	--	--	--
Gover Creek		--	--	--	--	--	--	--	--	--	1	0	--	--	--	--
Stony Creek		--	--	--	--	--	--	--	--	4	0	0	--	--	--	--
Total for all streams		3	1	2	2	2	13	32	58	68	81	54	111	70	85	89

Table 21. The status of bull trout populations during 2008 in each of the cores areas that occur in the Idaho Panhandle Region.

Core Area	2008 adult bull trout population estimate	Recovery goal	No. of local populations that have more than 100 adults	Recovery goal	Is this population stable or increasing?	Have 10 or more years of data been collected?	Are there streams that have known man-made barriers that block bull trout migrations?
Priest Lake	70	1,000	0	5	no	yes	yes - Gold Creek
Kootenai River	531	1,000	2	5	no	yes	none in Idaho
Pend Oreille Lake	1,872	2,500	6	6	yes	yes	yes - Clark Fork and Pend Oreille rivers
Coeur d'Alene Lake	362	1,100	1	NA	yes	yes	yes - Red Ives, Entente, Cascade and Bluebell
N.F. Clearwater River	932	5,000	21[a]	11[a]	yes	no	None in L.N.F. Clearwater

[a] A total of 100 adults or more are not required.

2008 Panhandle Region Fishery Management Report

ST. JOE RIVER AND NORTH FORK COEUR D'ALENE RIVER SNORKEL SURVEYS

ABSTRACT

In order to estimate fish density and size distribution, IDFG personnel snorkeled a total of 35 transects in the St. Joe River and 43 in the North Fork Coeur d'Alene River system. Total densities of age-1 and older westslope cutthroat trout were 1.02 fish/100 m^2 in the St. Joe River and 0.84 fish/100 m^2 in the North Fork Coeur d'Alene River system. Although total density counts in the N.F. Coeur d'Alene River was down 20% from 2007, both rivers showed increasing trends in abundance of cutthroat trout following the declines observed after the 1996 and 1997 flood events. Densities of cutthroat trout ≥ 300 mm in length were 0.25 fish/100 m^2 in the St. Joe River and 0.17 fish/100 m^2 in the North Fork Coeur d'Alene River. Although densities of cutthroat trout ≥ 300 mm in both rivers were down approximately 25% from 2007 counts, both rivers show increasing trends in abundance following the declines observed after the 1996 and 1997 flood events.

Densities of mountain whitefish were 1.20 fish/100 m^2 in the St. Joe River and 2.21 fish/100 m^2 in the North Fork Coeur d'Alene River during 2008. Similar to cutthroat, both rivers showed lower densities than 2007; however, the overall trend is increasing in abundance of following the declines observed after the 1996 and 1997 flood events.

A total of nine rainbow trout were observed in the St. Joe River and 232 (0.14 fish/100 m^2) were observed in the North Fork Coeur d'Alene River during 2008. No rainbow trout were observed upstream of the town of Calder in the St. Joe River. In the North Fork Coeur d'Alene River all the rainbow trout were observed downstream in the reaches below Yellow Dog Creek.

No bull trout were observed in the St. Joe River in 2008.

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INTRODUCTION

Past research found that declines in the fishery were directly related to over harvest in the St. Joe River and a combination of over harvest, habitat degradation and toxic mine wastes in the Coeur d'Alene River (Rankel 1971; Bowler 1974; Lewynsky 1986; Rabe and Sappington 1970; Mink et al. 1971). Efforts such as habitat improvements and fishing regulation reform were initiated early on to try and mitigate the causes for these declines in the fishery. As a result, cutthroat populations have increased significantly and are now widely renowned fisheries in Idaho.

Snorkel transects for monitoring fish abundance were established in the St. Joe River in 1969 and in the Coeur d'Alene River in 1973 (Rankel 1971; Bowler 1974). The long term trend data sets collected from these snorkel transects are very important in documenting how changes in fishing regulations, habitat, and weather patterns influence trends in fish populations.

OBJECTIVE

1. Estimate salmonid density and abundance trends in snorkeling transects of the St. Joe and North Fork Coeur d'Alene rivers and evaluate how changes in fishing regulations, habitat, and weather patterns may have influenced the fishery.

STUDY SITES

St. Joe River

During the 2008 season, a total of 35 snorkel transects occur in the St. Joe River spanning a total of 115 km of river (Figure 67). Coordinates and photographs as well as a history of site changes for the location of each of these transects are described in DuPont et al. 2009. The photos in DuPont et al. (2009) not only show a picture of the transects, but also depict where snorkeling should start and end and the approximate length of stream that should be snorkeled.

North Fork Coeur d'Alene River

In the North Fork Coeur d'Alene River, twenty-three snorkel transects were located in the main river system (85 river km), 13 were in the Little North Fork Coeur d'Alene River (45 river km) and five were in Tepee Creek (8 river km). Some of the transect locations have been changed over the years as the river has shifted positions and pools have filled in (see DuPont et al. 2009). The total number of transects that were snorkeled in the Coeur d'Alene basin during 2008 was 43, which spans about 138 km of river (Figure 68).

METHODS

Field Work

Snorkeling was used to evaluate trends in fish abundance in the St. Joe and Coeur d'Alene rivers following standardized methods described by DuPont et al. (2009).

Transects on the North Fork Coeur d'Alene River were snorkeled during the first week in August, and the St. Joe was sampled the second week, which is consistent with previous years sampling dates.

Data Analysis

Fish counts for each transect were converted to density (fish/100 m^2) to standardize the data and make it possible to compare counts within the watershed as well as to other watersheds. Average densities of each salmonid species (all sizes) and for cutthroat trout ≥ 300 mm were calculated for the entire St. Joe River and North Fork Coeur d'Alene River system as well as for different stream reaches within each watershed. The densities of these fishes were added to the long-term data set to evaluate their trends in abundance.

To evaluate whether densities of cutthroat trout differed between the stream reaches in the St. Joe River and North Fork Coeur d'Alene River system we conducted an analysis of variance (ANOVA) on the density of fish in each of the transect sites. We used a p-value ≤ 0.10 to denote when a significant difference in density occurred between stream reaches. This value is often used to show significance when evaluating fish and wildlife populations for management purposes (Peterman 1990; Johnson 1999; Anderson et al. 2000). When an ANOVA showed that a significant difference ($p \leq 0.10$) in cutthroat trout density occurred between the stream reaches we used Fisher's Least-Significant-Difference (LSD) Test to evaluate which stream reaches differed significantly. Fisher's Least-Significant-Difference Test was chosen for this analysis as this test tends to maximize the power, which increases that ability to show statistically significant differences with low sample sizes (Milliken and Johnson 1992).

RESULTS

St. Joe River

A total of 35 transects were snorkeled in the St. Joe River from August 11-14, 2008. During these surveys, 1,127 cutthroat trout, 9 rainbow trout, and 1,333 mountain whitefish were counted (Table 22). No bull trout were observed in any transect. Cutthroat trout were observed in 32 of the 35 transects snorkeled. Densities of cutthroat trout (all size classes) at these transects ranged from 0.00 to 6.09 fish/100 m^2 with an overall average of 1.02 fish/100 m^2 (Tables 22 and 23). About 24% of the cutthroat trout observed were estimated to be ≥ 300 mm in length and their overall density was calculated to be 0.25 fish/100 m^2 (Table 22 and Table 23). Total densities of cutthroat trout show an increasing trend since they were first started in 1969, and are up 20% from densities estimated in 2007 (Table 23; Figure 69). Although overall densities are up, densities of cutthroat > 300mm is down 22% from 2007 estimates (Table 23; Figure 69).

ANOVA testing indicated that significant differences (p value = 0.007) in density of cutthroat trout (all size classes) occurred between stream reaches in the St. Joe River (Figure 70). Fisher's LSD test (Table 24) showed that there were significantly higher densities of cutthroat trout upstream of Prospector Creek than the downstream of it (Table 23). ANOVA testing on only cutthroat trout ≥ 300 mm, showed no significant differences (p value = 0.209) in densities occurring between stream reaches (Figure 70); therefore, no Fisher's LSD test was performed.

Fishing regulations on the St. Joe have changed multiple times since density monitoring was set up in 1969 from North Fork St. Joe River to Ruby Creek (Table 25; Figure 70). For a full explanation of historical changes and how they affected cutthroat trout densities throughout the drainage, see DuPont et al. (2009). A recent regulation change to catch-and-release of all cutthroat trout was implemented in the spring of 2008 for the entire Spokane River drainage (Table 25).

Mountain whitefish were counted in 32 of the 35 transects snorkeled during 2008 and were the most numerous fish observed (Table 22). The highest density of mountain whitefish (1.83 fish/100 m^2) was observed in the reach between the Red Ives Creek and Ruby Creek (Table 26). The overall mean density of mountain whitefish we observed in 2008 was 1.38 fish/100 m^2.

A total of nine rainbow trout were counted during 2008. None of these counts were of the rainbow trout were observed upstream of the town of Calder (Table 27).

No bull trout were counted in snorkel transects in 2008. This is only the third time since 1989 that we have not observed bull trout while snorkeling the St. Joe River.

Mean annual flow in the St. Joe River as measured at Calder was 2,580 cfs and peak flow was recorded at 23,100 cfs in May, 2008. This was the highest flow recorded since 2002; however, is considerably less that the flow recorded in 1996 at 39,200 cfs (Figure 71). The flow recorded in February 1996 was the second highest peak flow event since 1950 and was followed in 1997 by the fifth highest mean annual flow year since 1950.

North Fork Coeur d'Alene River

Forty-three transects were snorkeled in the North Fork Coeur d'Alene River system from August 1-5, 2008 (Table 28). A total of 1,413 cutthroat trout, 232 rainbow trout, 5 brook trout and 3,685 mountain whitefish were counted (Table 28). Cutthroat trout were observed in 38 of the 43 transects snorkeled. Densities of cutthroat trout (all size classes) in these transects ranged from 0.00 to 7.86 fish/100 m^2 with an overall average of 0.84 fish/100 m^2 (Tables 28 and 29). About 20% of the cutthroat trout observed were estimated to be ≥ 300 mm in length and their overall density was calculated to be 0.17 fish/100 m^2 (Table 29). Although total densities of cutthroat trout were down 20% from those estimated in 2007, an increasing trend exists across all size classes since monitoring began in 1973 (Table 29; Figure 72). Overall densities of cutthroat > 300mm are also down 25% from the previous season's estimates (Table 29; Figure 72). In the Tepee Creek rehabilitation section of the drainage, average densities were 0.29 cutthroat trout/100 m^2 (all size classes combined). These densities were the lowest counted in this stream reach since 2004; however, densities have fluctuated greatly since we first started snorkeling them in 2002 (Table 29).

ANOVA testing indicated that no significant differences ($p = 0.91$ and 0.22) in density of cutthroat trout (all size groups or > 300 mm) occurred between any of the stream reaches sampled in the North Fork Coeur d'Alene River system (Figure 73). As a result, no Fisher's pair wise comparisons could be interpreted.

As with the St. Joe River, a recent regulation change to catch-and-release only of westslope cutthroat trout was implemented in the spring of 2008 (Table 25). For a full explanation of historical changes and how they affected cutthroat trout densities throughout the drainage, see DuPont et al. 2009.

Mountain whitefish were observed in 17 snorkel transects in the North Fork Coeur d'Alene River system in 2008 and densities ranged from 0.00 to 8.43 fish/100 m^2 with a mean density of 2.21 fish/100 m^2 (Table 30). The highest densities of mountain whitefish were observed in the lower North Fork Coeur d'Alene River, with few observed in the Little North Fork and none upstream of Tepee Creek (Table 30).

Rainbow trout were observed in 15 snorkel transects during 2008 and densities ranged from 0.00 to 5.19 fish/100 m^2 with a mean density of 0.14 fish/100 m^2 (Table 31). All of the rainbow trout were observed in the most downstream reaches of the North Fork and Little North Fork (Table 31). Of the 232 rainbow trout observed, 49 (27%) were estimated to be ≥ 300 mm in length.

Mean annual flow in the North Fork Coeur d'Alene drainage as measured at Enaville was 2,123 cfs and peak flow was recorded at 27,400 cfs in May, 2008. This was the highest flow recorded since 2002; however, is considerably less that the flow recorded in 1996 at 56,600 cfs (Figure 74). The flow recorded in February 1996 was the second highest peak flow event since 1950.

St. Joe River versus the North Fork Coeur d'Alene River System

The catch-and-release areas in both the St. Joe River and North Coeur d'Alene River systems have been snorkeled consistently since 1993 allowing direct year to year comparisons in density of cutthroat trout. However, since the entire basin is now catch-and-release starting in 2008, comparisons will now reflect drainage wide differences in densities.

The average density of cutthroat trout (all size classes) in the North Fork Coeur d'Alene River (0.84 fish/100 m^2) was lower than we observed in the St. Joe River (1.02 fish/100 m^2) during 2008. When statistically tested (T-test evaluation) the densities of cutthroat trout in the St. Joe were significantly ($p = 0.052$) higher than those found in the North Fork Coeur d'Alene River. Similarly, the density of cutthroat trout ≥ 300 mm observed in the St. Joe River (0.25 fish/100 m^2) transects was significantly higher ($p = 0.034$) than what was observed in the North Fork Coeur d'Alene River system (0.17 fish/ 100 m^2) during 2008.

DISCUSSION

Cutthroat trout

St. Joe River

Cutthroat trout densities in the St. Joe have increased steadily since snorkel counts were first initiated in 1969. Early research indicated the depressed cutthroat trout fishery was a result of over-fishing (Mallet 1967; Dunn 1968; Rankel 1971). Changes in fishing regulations over the past three decades in combination with habitat improvement programs throughout the basin have provided what is now one of Idaho's premier trout fisheries.

Total densities of cutthroat trout across all size classes in the St. Joe River were 20% higher this year compared to 2007. At the same time, however, densities of fish > 300mm were the same magnitude lower when looking at the entire river. The 2008 spring flows, which peaked at around 23,100 cfs in May, could have been partially responsible for the reduced numbers of these size classes as well as why lower reaches showed an 18% increase in densities of > 300mm cutthroat. Flood events have been shown to dramatically impact fish populations through bedload movement, shifts in channel morphology, armoring of spawning habitat, and the destruction of overwintering and summer feeding habitats (Swanston 1991; Pearson et al. 1992; Abbott 2000; DeVries 2000). Although the flood event in 1996 was some 16,000 cfs higher, it caused similar declines in cutthroat trout abundance. The decline in cutthroat trout abundance following the flood of 1996 was more pronounced for cutthroat ≥ 300 mm as densities were 5.6 times higher prior to the flood then they were following the flood in 1998. Although peak flows similar to 2008 were seen in the spring of 2002, the densities of fish > 300mm increased the following years. This makes it difficult to completely correlate the reduction of larger fish in 2008 solely to increased discharge.

Wide fluctuations in density over the past three decades are difficult to interpret due to the environmental and human variables involved. However, a benefit to the regulation change to full catch-and-release of cutthroat in the drainage is that it eliminates harvest mortality, which may make it easier in the future to correlate factors such as flood events to changes in fish density. Hooking mortality, however, may still play a role in density changes in the St. Joe. Schill et al (1986) found in the Yellowstone River (catch-and-release regulations) that cutthroat trout were captured on average about 10 times a year resulting in an annual fishing mortality of about 3%.

Once cutthroat trout in the St. Joe River recovered from the floods of 1996, their densities have remained relatively steady. Overall cutthroat trout densities from 1997 to 2008 on average are still below what was observed before the flood, whereas densities of cutthroat trout ≥ 300 mm have remained high. Cutthroat trout ≥ 300 mm represented 25-40% of all fish observed in the St. Joe River between 2004 and 2008, which is the highest we have ever recorded. The combination of mild winters and extending the catch-and-release reach of the river by approximately 20 rkm, while maintaining a slot between 203 and 406 mm (8 and 16 in) on the remainder of the river, are thought to be responsible for such increases (DuPont et al. 2009).

North Fork Coeur d'Alene River System

As with the St. Joe system, cutthroat trout densities have increased since 1973. Much of this increase can be attributed to regulation changes and improved timber management policies throughout the basin. For a detailed breakdown of basin wide changes and how they correlate to changes in fish densities see DuPont et al. (2009).

Although the trend in population densities is increasing, the 2008 season in the North Fork showed a 20% reduction in densities across all size classes from the previous year's estimates. As with the St. Joe River, the 2008 spring flows, which peaked at around 27,000 cfs in May, could have been partially responsible for the reduced numbers of these size classes. Unlike the St. Joe, no increases in larger size classes were seen in the lower river section, which may allude to relocation in direct response to unfavorable flows in the upper river sections. However, it is difficult to completely attribute this reduction to flow until several additional years of information are collected. Large fluctuations in cutthroat trout densities are not uncommon in Idaho rivers and have even been documented in wilderness rivers (Selway and Middle Fork Salmon) where fishing pressure and habitat degradation are usually not issues (Dupont et al. 2009). Telemetry worked conducted by DuPont et al. (In Press) in the Coeur d'Alene River watershed showed that larger cutthroat trout migrate to thermal refuges during summer months. Taking this into consideration, mean daily temperatures in the North Fork could and may have significantly affected accuracy of counts depending on the year.

Despite the reduction from last year, densities of cutthroat trout from 2004-2008 are well above the densities prior to the 1996 flood which sent 56,600 cfs down the river and likely caused the reduction of cutthroat in subsequent years. Following the floods (post 1998), densities of cutthroat trout increased steadily to the point where successive all time highs were observed between 2005 and 2008. The average densities were over seven times higher in 2008 than what was observed in 1973 in snorkel sites on the main North Fork. Although down from 2007, densities of cutthroat trout ≥ 300 mm in 2008 were the fourth highest recorded and 15 times higher than was observed in 1973. These findings suggest that survival of larger cutthroat trout is improving.

The cutthroat population in the Little North Fork has also shown remarkable improvements since first monitoring began. The Little North Fork has habitat that is considered relatively poor (DuPont et al. 2008). Splash damming used to transport wood from the basin prior to 1930 (Strong and Webb 1970) seriously degraded habitat in this watershed. Despite the degraded nature of the Little North Fork, the snorkel data does indicate the cutthroat trout population is improving. The density of cutthroat trout ≥ 300 mm also appears to be improving, but at a slower rate than the smaller fish.

St. Joe River versus the North Fork Coeur d'Alene River System

Overall, cutthroat trout densities in the North Fork Coeur d'Alene River are lower than we observe in the St. Joe River. From 1993 to 1997 cutthroat trout densities were usually two to three times higher in the catch-and-release area of the St. Joe River than what was observed in the catch and release area of the North Fork Coeur d'Alene River.

Historically, declines in density following a flood event tend to be greater in the St. Joe River than in the North Fork Coeur d'Alene River system (Dupont et al. 2009). Dupont et al. (2009) attributed this to the St. Joe's geomorphology where confined sidewalls of the canyon leave few areas for cutthroat trout to conserve energy during high flows, possibly lending to increased mortality. This was not the case in 2008 where the reduction in densities in the North

Fork Coeur d' Alene River were more prominent in 2008 than those experienced by the St. Joe River. This most likely would be the case, however, in extreme flood events such as that experienced in 1996. The flood event experienced in 2008 was lower in magnitude than 1996 and was experienced in May rather than February. Continued evaluations will give us a better in sight on whether or not this increased reduction in densities was truly a function of river discharge.

Mountain Whitefish

Mountain whitefish in the North Fork Coeur d' Alene River have increased in abundance since 1973, though populations exhibit extreme highs and lows in density throughout the past three decades of monitoring. Many of the down years occur immediately after unusually cold winters (1979-1980; 1992-1993) or flood events (1996). Despite drops in density by 75% to 85%, the whitefish population typically bounced back in about three years.

The estimated densities declined by 42% from 2007. Since mountain whitefish have been long thought of as a key indicator of stream perturbations (McPhail and Troffe 1998), this may indicate the increased spring flow was a factor of mortality this season. Despite this drop in density, whitefish populations are 2.5 times higher than when we began monitoring in 1973 and the population still remains strong.

Our snorkel surveys showed that mountain whitefish densities had remained fairly steady in the St. Joe River from 1969 until 1997, and then a fairly significant decline was documented. In all likelihood, the decrease in mountain whitefish densities in 1997 was a response to flood events during 1996 and 1997. Since then, mountain whitefish densities have rebounded and are now about what was observed before the floods. Mild winters from 1998 to 2003 may have facilitated this rapid recovery (DuPont et al. 2009).

Snorkel surveys indicated that mountain whitefish densities in the North Fork Coeur d'Alene River system were about 1.8 times higher than what was observed in the St. Joe River during 2008. Most whitefish in the in both systems were observed in the large, deep pools and runs in the more downstream transects.

It is an important to note that mountain whitefish counts can vary widely on an annual basis depending on the observers. Snorkelers often drift over a pool that may have 600-1,000 mountain whitefish in a group (mixed with large-scale suckers and northern pikeminnow), which, depending on water conditions, can make a precise estimate on density difficult. Although variations in the counts can occur, overall trends still look to be increasing in both systems. One other thing to consider is that many mountain whitefish will move into cold water refugia in the lower North Fork during the warm summer months (DuPont et al. in Press). As with cutthroat density estimates, it may be worthwhile factoring mean daily temperatures in the North Fork when interpreting the accuracy of counts across years.

Rainbow Trout

Similar to mountain whitefish, rainbow trout densities are down 42% from 2007 counts in the North Fork Coeur d'Alene River. Rainbow trout stocking in the Idaho Panhandle's rivers or streams (including the North Fork) ceased in 2002. Not surprising, a decline in the density of rainbow trout was observed in 2003. However, since 2003, the abundance of rainbow trout has remained relatively steady from a low level of natural reproduction in the system. DuPont et al. (2009) speculated that natural reproducing of rainbows exists in the North Fork downstream of Shoshone Creek and downstream of Laverne Creek in the Little North Fork Coeur d'Alene River.

The current fishing regulations allow six rainbow trout of any size to be harvested from the Coeur d'Alene River system. These regulations do not appear to be causing the rainbow trout population to be declining in abundance, although they may be keeping the rainbow trout population from increasing.

The rainbow trout population in the St. Joe River looks to be stabilized at an extremely low level since stocking stopped in 2002. Few rainbows are observed in transects above the North Fork of the St. Joe River (none in 2008), which indicates that very little natural reproduction and overwinter survival is occurring upstream of the North Fork St. Joe River.

Bull trout

Few bull trout have been observed while conducting snorkel surveys in the St. Joe River. In fact, no more than four bull trout have been observed while conducting these snorkel surveys since 1977. In 2008, we did not observe any bull trout while conducting our snorkel surveys. Because few bull trout are seen while conducting these snorkel surveys, it is best not to use these counts to speculate on trends in their abundance. For example, a record high number of bull trout redds were counted in the St. Joe watershed during 2007 (redd counts were initiated in 1992).

MANAGEMENT RECOMMENDATIONS

1. Continue to monitor cutthroat trout abundance in the St. Joe River and North Fork Coeur d'Alene River through snorkel surveys on an annual basis.

2. Further analyze the effects of extreme river temperatures in the North Fork Coeur d'Alene River (fish utilizing thermal refugia) as they correlate to variation in density counts of cutthroat, mountain whitefish, and rainbow trout.

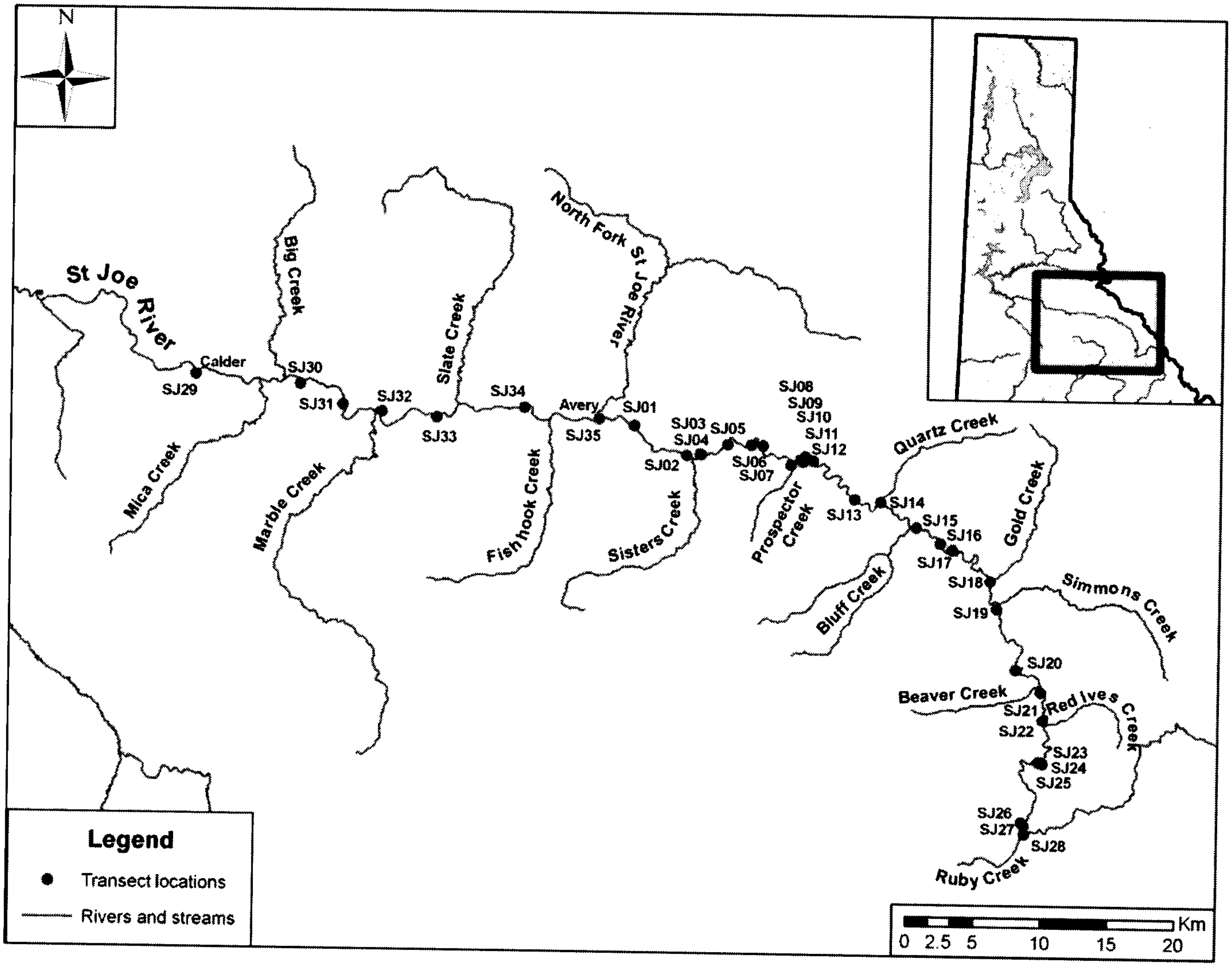


Figure 67. Location of 35 transects that were snorkeled on the St. Joe River, Idaho, during August 12-14, 2008.

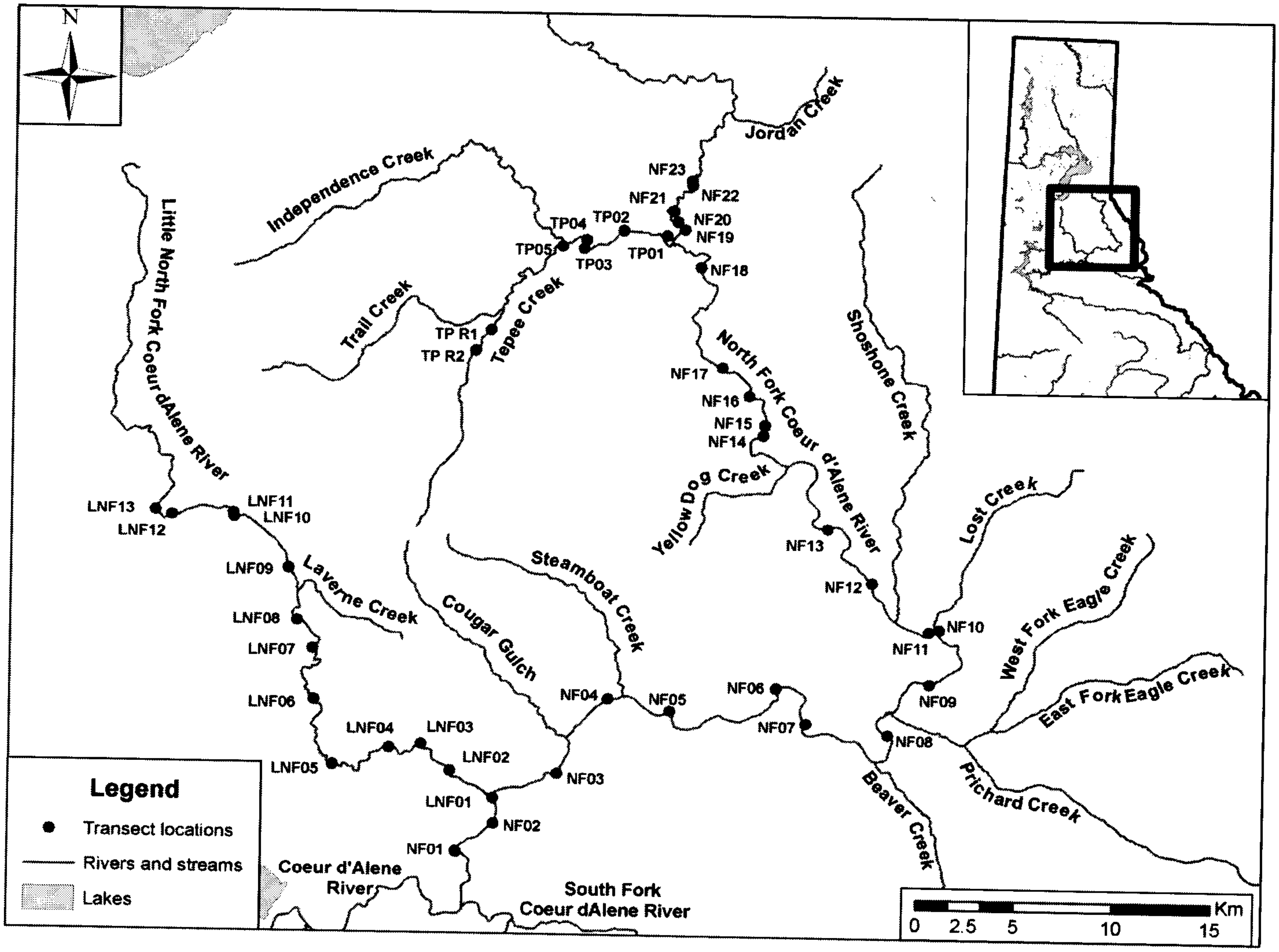


Figure 68. Location of 43 transects snorkeled on the Coeur d'Alene River, Idaho, during August 5-7, 2008.

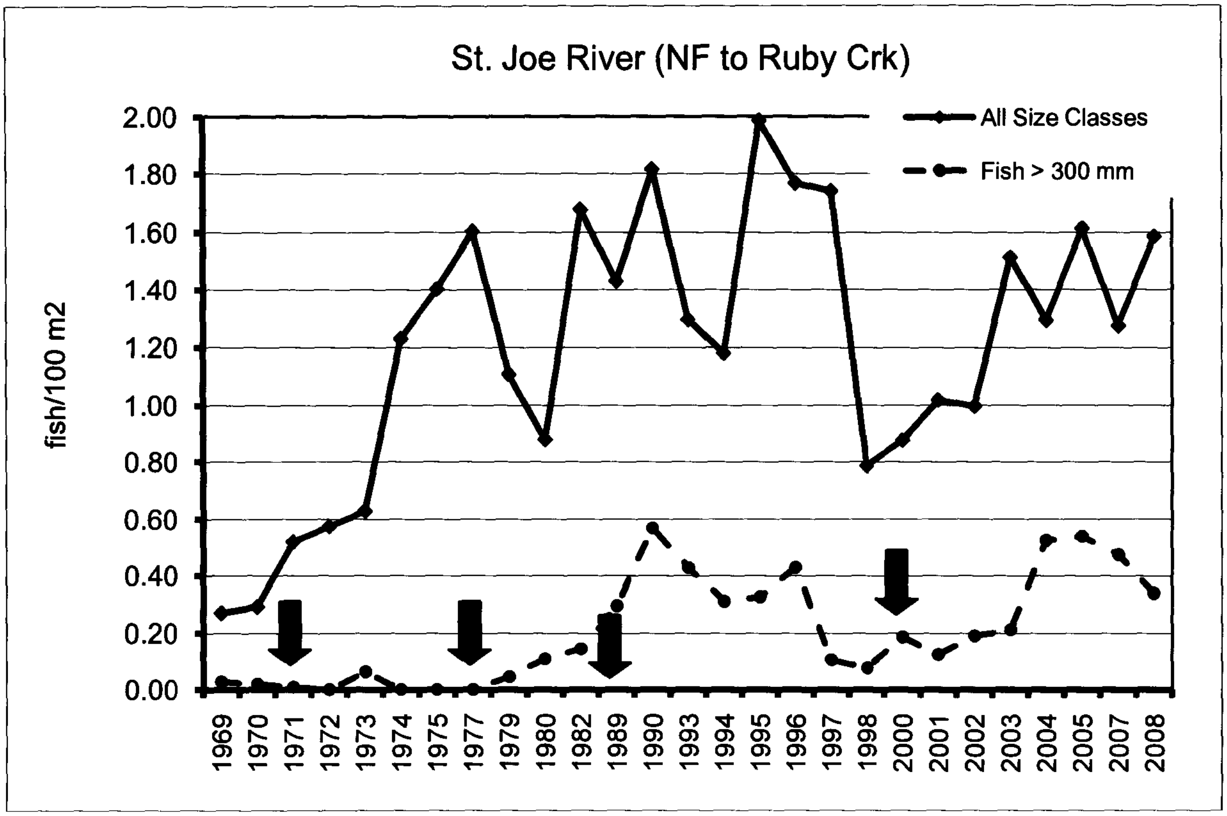


Figure 69. Average density (fish/100 m^2) of all size classes of cutthroat trout and cutthroat trout ≥ 300 mm observed while snorkeling the St. Joe River, Idaho, between the North Fork St. Joe River and Ruby Creek from 1969 to 2008. Arrows signify when significant changes occurred in cutthroat trout fishing regulations. Refer to Table 5 to see how regulations changed in these years.

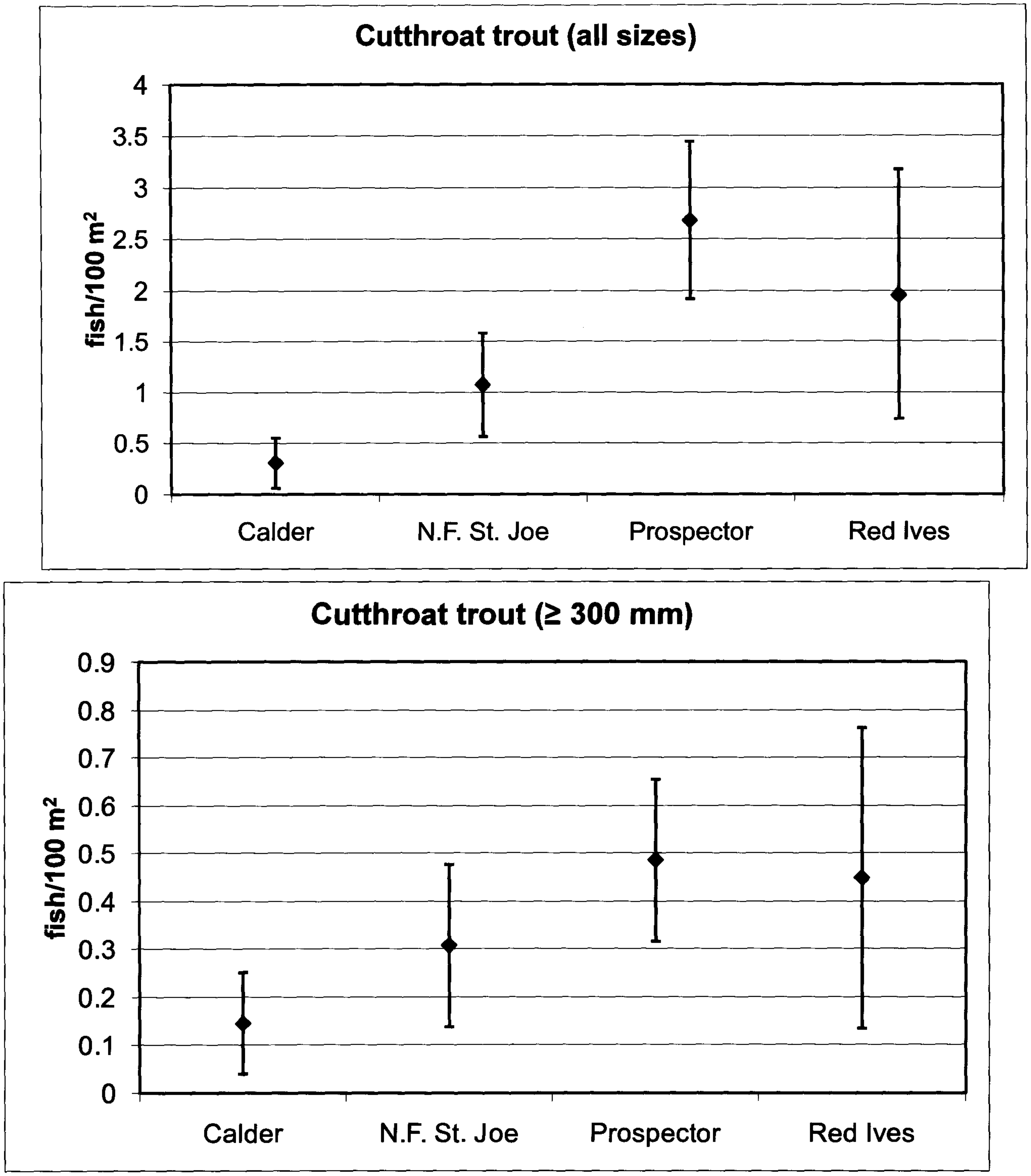


Figure 70. Mean cutthroat trout density and 90% confidence intervals (all sizes and only those ≥ 300 mm) determined from snorkeling four different reaches in the St. Joe River, Idaho, during 2008.

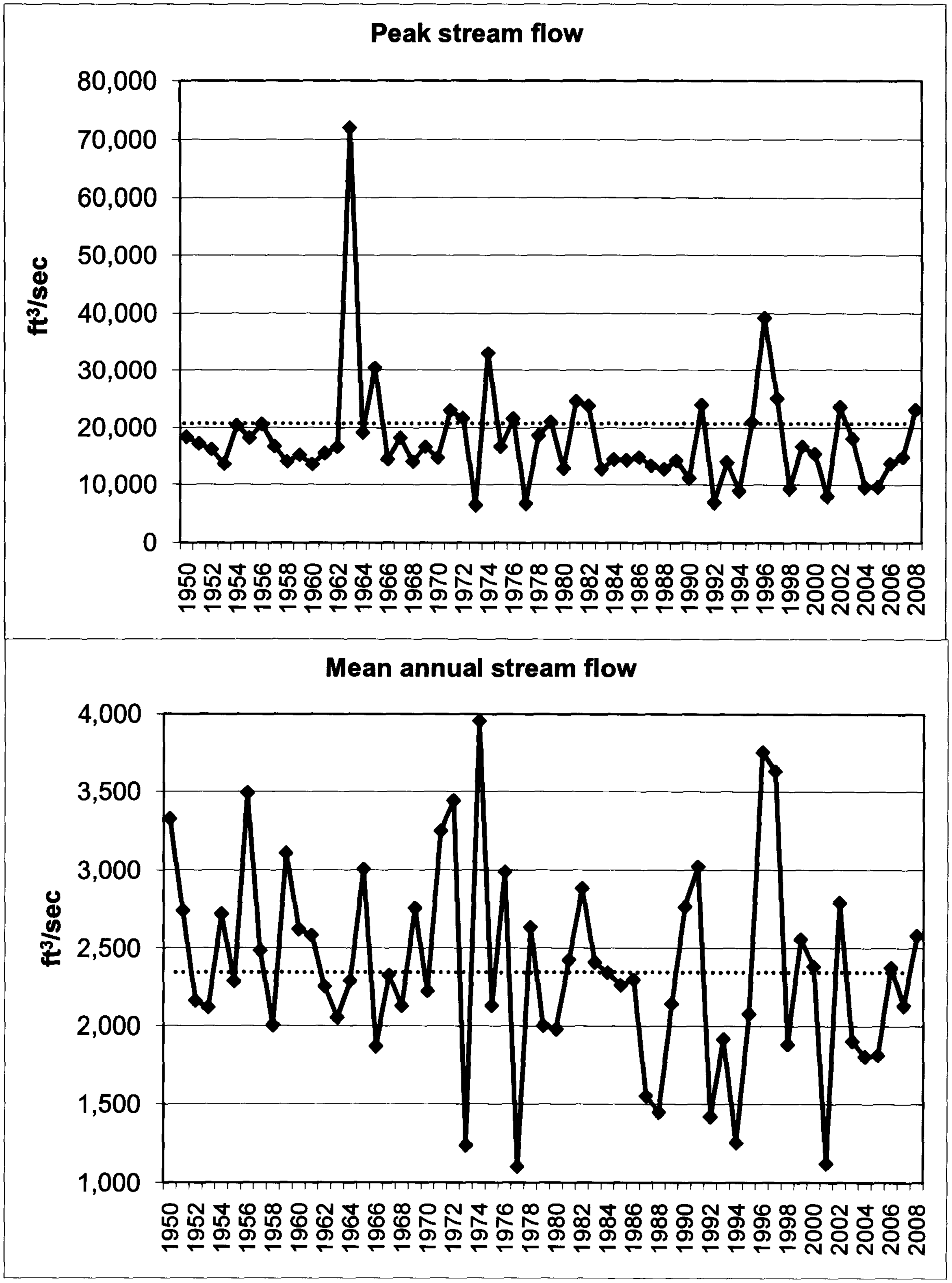


Figure 71. Peak stream flow and mean annual stream flow documented by USGS for the St. Joe River, Idaho, at Calder from 1950 to 2008. The dotted lines indicate the average flow since 1950.

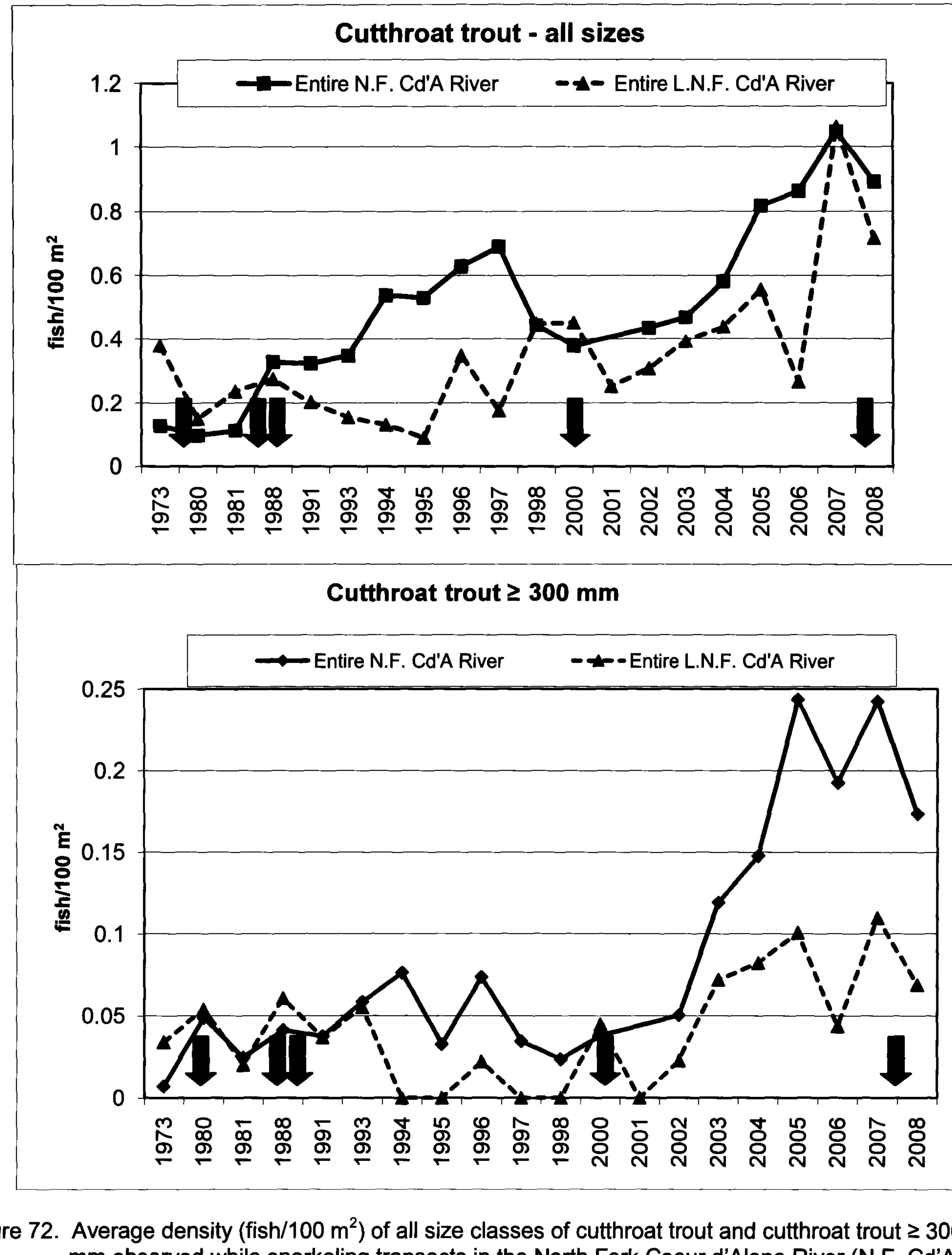
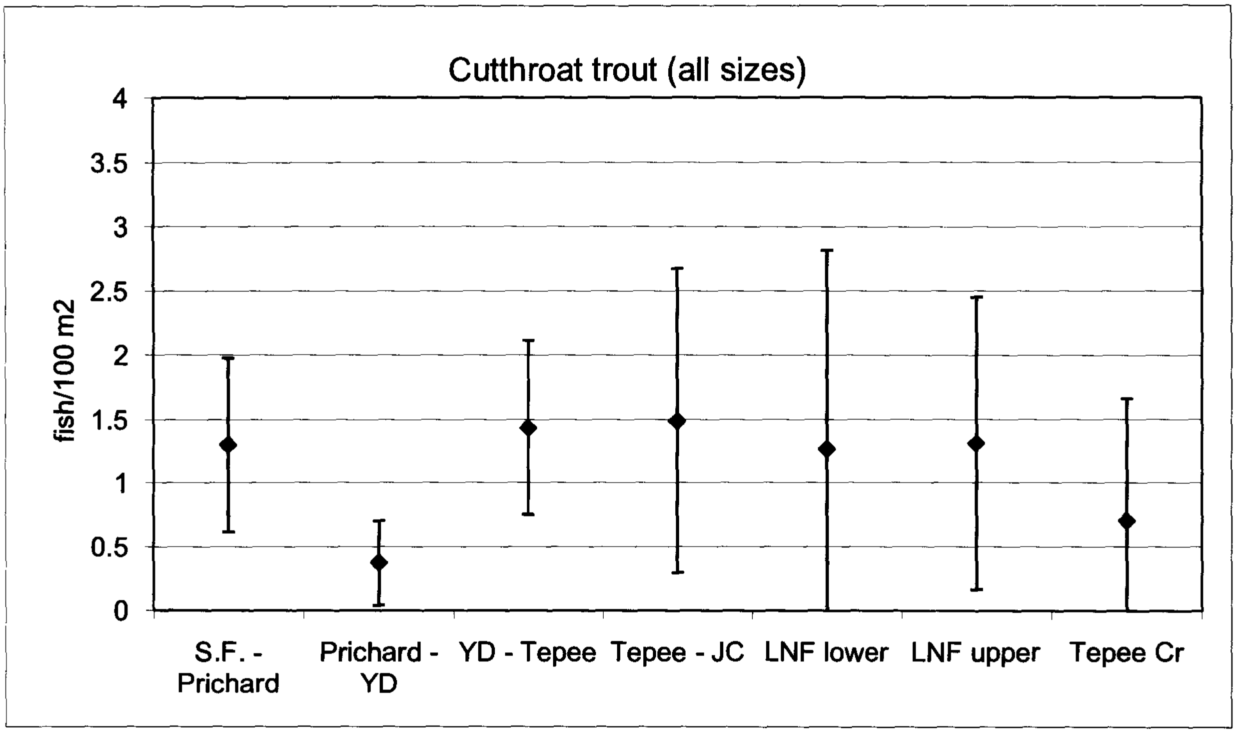


Figure 72. Average density (fish/100 m^2) of all size classes of cutthroat trout and cutthroat trout ≥ 300 mm observed while snorkeling transects in the North Fork Coeur d'Alene River (N.F. Cd'A) and Little North Fork Coeur d'Alene River (L.N.F. Cd'A), Idaho, from 1973 to 2008. Arrows signify when significant changes occurred in the cutthroat trout fishing regulations. Refer to Table 5 to see how regulations changed in these years.



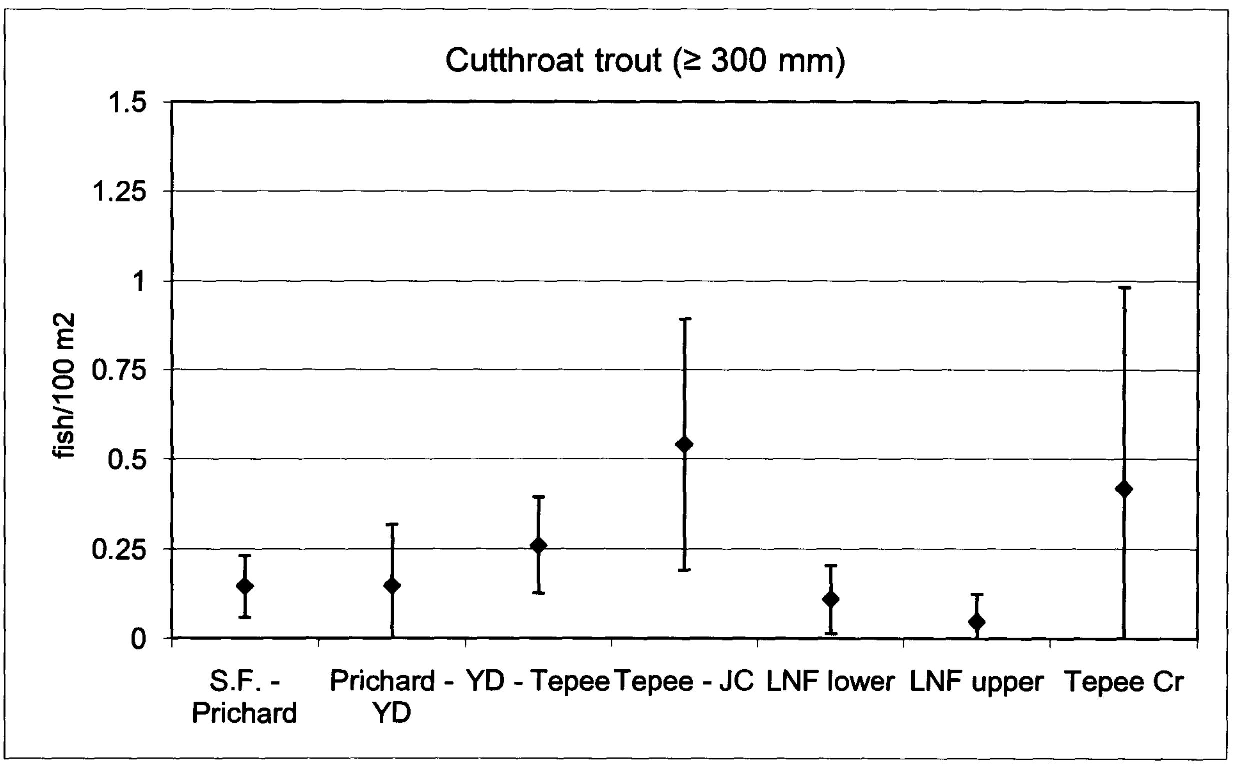
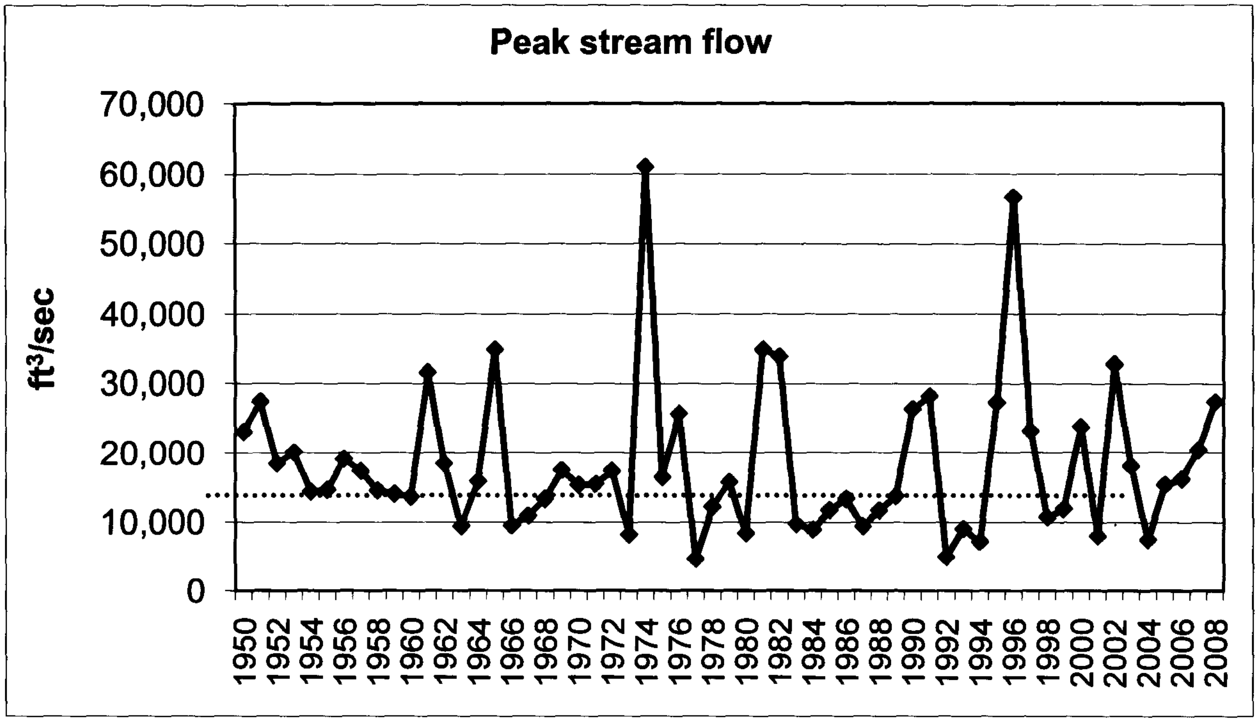


Figure 73. Average density (fish/100 m^2) of cutthroat trout and 90% confidence intervals (all sizes and only fish ≥ 300 mm) observed while snorkeling transects in seven different reaches in the North Fork Coeur d'Alene River watershed, Idaho, during 2008.



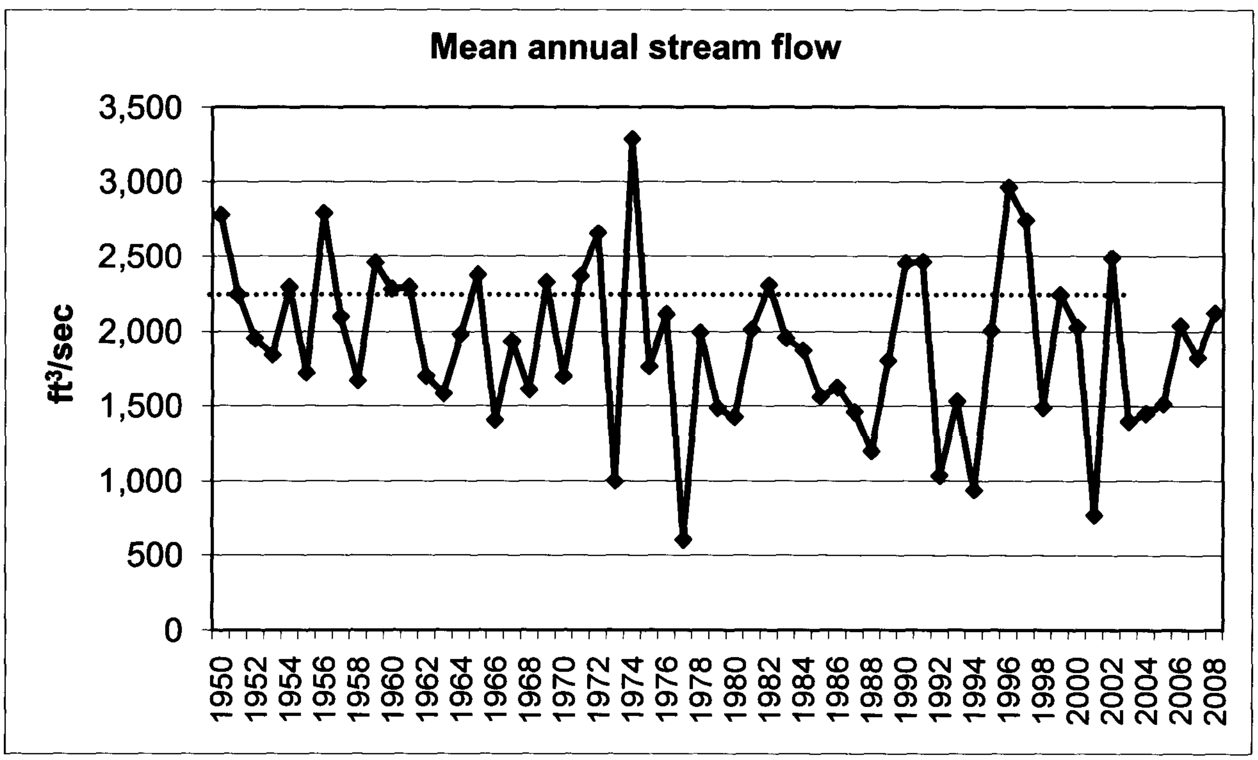


Figure 74. Peak stream flow and mean annual stream flow documented by USGS for the North Fork Coeur d'Alene River, Idaho, at Enaville from 1950 to 2008. The dotted line indicates the average flow since 1950.

Table 22. Number and density of fishes observed while snorkeling transects in the St. Joe River, Idaho, during August 11-14, 2008.

Reach	Transect	Area (m^2) snorkeled	Cutthroat trout			Rainbow trout counted	Mountain whitefish		Largescale sucker counted	Northern pikeminnow counted	Salmonid density (No./100 m^2)
			Number counted ≥300mm	Number counted all sizes	Density (No./100 m^2)		Number counted	Density (No./100 m^2)			
N.F. St Joe River to Prospector Cr.	SJ01	4,120	0	0	0.00	0	1	0.02	0	0	0.00
	SJ02	3,578	19	74	2.07	0	180	5.03	125	158	0.07
	SJ03	1,190	6	15	1.26	0	37	3.11	0	4	0.04
	SJ04	1,101	3	10	0.91	0	6	0.55	0	0	0.01
	SJ05	3,292	23	72	2.19	0	41	1.25	0	3	0.03
	SJ06	7,020	6	45	0.64	0	41	0.58	1	23	0.01
	SJ07	5,016	3	22	0.44	0	22	0.44	0	10	0.01
Prospector Creek to Red Ives Creek	SJ08	2,743	3	51	1.86	0	71	2.59	0	80	0.04
	SJ09	2,098	19	56	2.67	0	25	1.19	0	17	0.04
	SJ10	6,075	18	66	1.09	0	63	1.04	0	23	0.02
	SJ11	3,019	12	43	1.42	0	50	1.66	0	1	0.03
	SJ12	2,342	7	32	1.37	0	35	1.49	0	11	0.03
	SJ13	3,177	11	57	1.79	0	57	1.79	0	39	0.04
	SJ14	2,672	10	38	1.42	0	50	1.87	0	13	0.03
	SJ15	2,133	5	40	1.88	0	3	0.14	0	0	0.02
	SJ16	1,085	4	55	5.07	0	5	0.46	0	0	0.06
	SJ17	1,806	6	65	3.60	0	25	1.38	0	7	0.05
	SJ18	815	13	48	5.89	0	20	2.45	0	0	0.08
	SJ19	1,166	4	46	3.95	0	4	0.34	0	0	0.04
	SJ20	1,620	3	15	0.93	0	0	0.00	0	0	0.01
	SJ21	739	8	45	6.09	0	35	4.74	0	1	0.11
	SJ22	1,793	7	21	1.17	0	6	0.33	0	6	0.02
Red Ives to Ruby Creek	SJ23	689	0	1	0.15	0	1	0.15	0	0	0.00
	SJ24	767	5	32	4.17	0	4	0.52	0	0	0.05
	SJ25	989	3	40	4.05	0	8	0.81	0	0	0.05
	SJ26	1,650	2	3	0.18	0	0	0.00	0	0	0.00
	SJ27	1,390	18	29	2.09	0	100	7.19	0	0	0.09
	SJ28	908	3	10	1.10	0	4	0.44	0	0	0.02
Calder to N.F. St. Joe	SJ29	7,674	9	12	0.16	0	65	0.85	295	65	0.01
	SJ30	10,415	5	6	0.06	0	15	0.14	290	320	0.00
	SJ31	7,340	1	2	0.03	0	50	0.68	180	175	0.01
	SJ32	6,562	6	10	0.15	0	71	1.08	61	49	0.01
	SJ33	6,446	0	0	0.00	0	0	0.00	0	0	0.00
	SJ34	2,512	7	21	0.84	5	98	3.90	37	15	0.05
	SJ35	4,913	23	45	0.92	4	140	2.85	75	50	0.04
Total	35	110,855	272	1,127	1.02	9	1,333	1.20	1,064	1,070	2.23

Table 23. Average densities (fish/100 m^2) of cutthroat trout (all sizes and only those ≥ 300 mm) counted by reach during snorkel evaluations from 1969 to 2008 in the St. Joe River, Idaho.

All sizes of cutthroat trout

Reach	1969	1970	1971	1972	1973	1974	1975	1976	1977	1979	1980	1982	1989	1990	1993	1994	1995	1996	1997	1998	2000	2001	2002	2003	2004	2005	2007	2008
Calder to North Fork St. Joe	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.07	0.23	0.16	0.14	0.15	0.09	--	■	0.11	0.11	--	--	0.13	0.21
N.F. St. Joe to Prospector Cr.	0.01	0.00	0.07	0.04	0.01	0.11	0.08	--	■	0.08	0.12	0.03	0.18	0.22	0.47	0.33	0.79	0.33	0.18	0.12	0.46	0.52	0.52	0.80	0.50	0.95	0.69	0.94
Prospector Cr. to Red Ives Cr.	0.25	0.31	0.58	0.59	0.76	1.40	1.53	3.59	1.72	1.63	1.50	2.93	2.44	2.79	2.13	1.66	2.56	2.42	2.79	1.05	1.11	1.38	1.46	2.01	1.76	2.15	1.48	2.04
Red Ives Cr. to Ruby Cr.	1.38	1.39	2.07	2.63	2.55	5.01	6.12	1.89	4.62	3.14	1.46	3.31	2.41	4.05	1.17	1.39	2.58	2.57	1.13	1.44	1.06	1.19	0.93	1.76	2.03	1.22	2.33	1.80
All transects - entire river	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.79	0.76	1.19	1.06	1.09	0.50	--	■	0.64	0.90	--	--	0.82	1.02
N.F. St. Joe to Ruby Creek	0.27	0.29	0.52	0.58	0.63	1.23	1.40	3.10	■	1.11	0.88	1.68	1.43	1.82	1.30	1.18	1.99	1.77	1.74	0.79	0.88	1.02	1.00	1.51	1.29	1.61	1.28	1.59

Cutthroat trout ≥ 300 mm

Reach	1969	1970	1971	1972	1973	1974	1975	1976	1977	1979	1980	1982	1989	1990	1993	1994	1995	1996	1997	1998	2000	2001	2002	2003	2004	2005	2007	2008
Calder to North Fork St. Joe	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	0.05	0.02	0.03	0.00	0.01	--	■	0.00	0.02	--	--	0.09	0.11
N.F. St. Joe to Prospector Cr.	0.01	0.00	0.00	0.00	0.00	0.00	0.00	--	■	0.00	0.01	0.00	0.02	0.09	0.08	0.02	0.05	0.07	0.01	0.01	0.12	0.04	0.07	0.17	0.20	0.29	0.27	0.24
Prospector Cr. to Red Ives Cr.	0.02	0.02	0.02	0.00	0.10	0.00	0.00	0.00	0.00	0.07	0.12	0.23	0.44	0.95	0.69	0.46	0.40	0.56	0.16	0.08	0.24	0.20	0.30	0.20	0.68	0.77	0.49	0.39
Red Ives Cr. to Ruby Cr.	0.12	0.11	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.17	0.47	0.40	0.81	0.88	0.72	0.47	0.70	0.76	0.13	0.26	0.18	0.11	0.24	0.41	0.95	0.27	1.15	0.48
All transects - entire river	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.26	0.20	0.19	0.25	0.06	0.05	--	■	0.12	0.13	--	--	0.32	0.25
N.F. St. Joe to Ruby Creek	0.03	0.02	0.01	0.00	0.06	0.00	0.00	0.00	■	0.05	0.11	0.15	0.30	0.57	0.43	0.31	0.33	0.43	0.11	0.08	0.19	0.13	0.19	0.21	0.52	0.54	0.47	0.34

1976 - transects 1-12 were not counted.
■ - transects 1-4 were not counted.
■ - transects 29-35 were in different locations than other years.

Table 24. Fishers Least-Significant-Difference Test matrices showing pairwise comparison probabilities of cutthroat trout densities (all sizes) between four stream reaches in the St. Joe River, Idaho, during 2008. Shaded cells indicate which stream reaches had significantly different ($p \leq 0.10$) cutthroat trout densities.

All sizes

	Calder.	N.F. St. Joe	Prospector	Red Ives
Calder	1			
N.F. St. Joe	0.259	1		
Prospector	[redacted]	[redacted]	1	
Red Ives	[redacted]	0.285	0.313	1

Table 25. History of fishing regulations for cutthroat trout in the St. Joe River and Coeur d'Alene River, Idaho, from 1941 to 2008.

St. Joe River			
Year	CdA Lake to N.F. St Joe	N.F. St. Joe to Prospector Cr.	Prospector Cr. to headwaters
1941-1945	15 lbs plus 1 fish - not to exceed 25 fish		
1946-1950	10 lbs plus 1 fish - not to exceed 20 fish		
1951-1954	7 lbs plus 1 fish - not to exceed 20 fish		
1955-1970	7 lbs plus 1 fish - not to exceed 15 fish		
1971	7 lbs plus 1 fish - not to exceed 15 fish		3 fish, none < 13 inches
1972-1975	7 lbs plus 1 fish - not to exceed 10 fish		3 fish, none < 13 inches
1976	10 fish, only 5 > 12 inches and 2 > 18 inches		3 fish, none < 13 inches
1977-1987	6 fish, only 2 > 16 inches		3 fish, none < 13 inches
1988-1999	1 fish, none < 14 inches		Catch-and-release
2000-2007	2 fish, none between 8"-16"	Catch-and-release	
2008-pres	Catch-and-release	Catch-and-release	

Coeur d'Alene River			
Year	CdA Lake to Yellow Dog Creek	Yellow Dog Creek to headwaters (NF CdA)	Laverne Creek to headwaters (LNF CdA)
1941-1945	15 lbs plus 1 fish - not to exceed 25 fish		
1946-1950	10 lbs plus 1 fish - not to exceed 20 fish		
1951-1954	7 lbs plus 1 fish - not to exceed 20 fish		
1955-1971	7 lbs plus 1 fish - not to exceed 15 fish		
1972-1974	7 lbs plus 1 fish - not to exceed 10 fish		
1975	7 lbs plus 1 fish - not to exceed 10 fish	3 fish, none < 13 inches	
1976	10 fish, only 5 > 12 inches & 2 > 18 inches	3 fish, none < 13 inches	
1977-1985	6 fish, only 2 > 16 inches	3 fish, none < 13 inches	
1986-1987	6 fish, only 2 > 16 inches	Catch-and-release	3 fish, none < 13 inches
1988-1999	1 fish, none < 14 inches	Catch-and-release	
2000-2007	2 fish, none between 8"-16"	Catch-and-release	
2008-pres	Catch-and-release	Catch-and-release	

Table 26. Average density (fish/100 m^2) of mountain whitefish counted by reach during snorkel surveys from 1969 to 2008 in the St. Joe River, Idaho.

Reach	1969	1970	1971	1972	1973	1974	1975	1976	1977	1979	1980	1982	1989	1990	1993	1994	1995	1996	1997	1998	2000	2001	2002	2003	2004	2005	2007	2008
Calder to N.F. St. Joe	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.60	0.18	0.34	0.88	0.44	0.10	--	[illegible]	0.33	0.80	--	--	0.95	0.96
N.F. St. Joe to Prospector Cr.	0.86	0.90	0.98	0.24	1.09	0.95	1.08	--		1.09	0.77		0.70	1.13	0.40	2.12	1.29	1.03	0.27	1.39	0.51	0.33	0.75	2.38	1.11	1.83	1.33	1.30
Prospector Cr. to Red Ives Cr.	1.24	1.16	1.12	0.82	3.72	1.33	0.97	0.71		1.69	1.20		2.17	2.01	2.11	0.65	1.67	1.02	0.47	0.80	0.55	1.22	1.22	1.87	1.59	1.15	2.34	1.35
Red Ives Cr. to Ruby Cr.	1.83	1.32	1.89	2.26	1.39	2.28	2.45	1.14	1.56	2.79	1.27		1.32	2.22	0.66	1.03	1.73	1.60	0.35	0.38	0.47	0.56	0.37	1.12	0.99	0.93	2.66	1.83
Average for all sites	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.95	0.75	1.03	1.01	0.41	0.60	--	[illegible]	0.68	1.47	--	--	1.59	1.20
NF St Joe to Ruby Creek	1.14	1.06	1.14	0.73	2.29	1.27	1.19	0.84		1.54	1.01		1.42	1.65	1.20	1.19	1.56	1.11	0.39	0.94	0.53	0.79	0.92	1.98	1.33	1.37	2.01	1.38

1976 -transects SJ01-SJ12 were not snorkeled.
- transects SJ01-SJ04 were not snorkeled.
- transects SJ05-SJ16 were only evaluated for presence/absence.
- transects SJ01-SJ25 were only evaluated for presence/absence.
- transect locations differed this year from other years.

Table 27. Average density (fish/100 m^2) of rainbow trout counted by reach during snorkel evaluations from 1969 to 2008 in the St. Joe River, Idaho.

Reach	1969	1970	1971	1972	1973	1974	1975	1976	1977	1979	1980	1982	1989	1990	1993	1994	1995	1996	1997	1998	2000	2001	2002	2003	2004	2005	2007	2008
Calder to N.F. St. Joe	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.14	0.10	0.21	0.20	0.03	0.15	--	[illegible]	0.04	0.03	--	--	0.02	0.02
N.F. St. Joe to Prospector Cr.	0.07	0.13	0.25	0.25	0.16	0.44	0.86	--		0.14	0.10	0.18	0.28	0.43	0.15	0.10	0.07	0.37	0.06	0.46	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00
Prospector Cr. to Red Ives Cr.	0.25	0.94	0.82	0.05	0.09	0.18	0.47	0.00	0.04	0.04	0.27	0.01	0.00	0.10	0.01	0.05	0.01	0.03	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
Red Ives Cr. to Ruby Cr.	0.11	0.41	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Average for all sites	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.10	0.08	0.11	0.17	0.02	0.16	0.00	[illegible]	0.02	0.01	--	--	0.01	0.01
NF St Joe to Ruby Creek	0.16	0.52	0.48	0.14	0.11	0.27	0.59	0.00		0.08	0.16	0.09	0.12	0.23	0.07	0.06	0.03	0.14	0.02	0.17	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00

1976 - transects SJ01-SJ12 were not snorkeled.
- transects SJ01-SJ04 were not snorkeled.
- transect locations differed this year from other years.

Table 28. Number and density (fish/100 m^2) of fishes observed while snorkeling transects in the North Fork Coeur d'Alene River drainage, Idaho, during August 5-7, 2008.

			Cutthroat Trout				Rainbow Trout		Mountain Whitefish		Largescale Sucker	Northern Pikeminno	Brook Trout	Salmonid
			Number counted			Density		Density		Density				Density
			<300mm	>300mm		(No./100		(No./100		(No./100				(No./100
Reach	Transect	Area (m2)			Total	m2)	Total	m2)	Total	m2)	Total	Total	Total	m2)
Lower North Fork	NF1	4,192	80	20	100	2.39	35	0.83	200	4.77	150	0	0	0.08
	NF1slough	648	5	0	5	0.77	6	0.93	46	7.10	0	0	0	0.09
	NF2	13,771	36	8	44	0.32	32	0.23	300	2.18	95	55	0	0.03
	NF3	12,659	60	5	65	0.51	50	0.39	630	4.98	100	40	0	0.06
	NF4	11,481	40	30	70	0.61	47	0.41	600	5.23	120	810	0	0.06
	NF5	6,983	19	0	19	0.27	0	0.00	75	1.07	25	30	0	0.01
	NF6	6,898	78	5	83	1.20	4	0.06	305	4.42	0	0	0	0.06
	NF7	7,343	100	20	120	1.63	1	0.01	312	4.25	206	0	0	0.06
	NF8	5,247	190	2	192	3.66	8	0.15	70	1.33	30	0	0	0.05
	NF9	10,806	22	8	30	0.28	4	0.04	5	0.05	0	0	0	0.00
	NF10	10,650	65	60	125	1.17	1	0.01	450	4.23	0	0	0	0.05
	NF11	8,001	14	2	16	0.20	0	0.00	1	0.01	0	0	0	0.00
	NF12	7,604	9	0	9	0.12	0	0.00	0	0.00	0	0	0	0.00
	NF13	3,156	1	2	3	0.10	0	0.00	0	0.00	0	0	0	0.00
Upper North Fork	NF14	3,883	69	5	74	1.91	0	0.00	327	8.42	0	0	0	0.10
	NF15	2,645	48	15	63	2.38	0	0.00	164	6.20	0	0	0	0.09
	NF16	2,503	4	5	9	0.36	0	0.00	0	0.00	0	0	0	0.00
	NF17	7,396	30	9	39	0.53	0	0.00	15	0.20	0	0	0	0.01
	NF18	2,158	37	6	43	1.99	0	0.00	182	8.43	0	0	0	0.10
	NF19	1,211	33	15	48	3.97	0	0.00	0	0.00	0	0	0	0.04
	NF20	1,177	4	3	7	0.59	0	0.00	0	0.00	0	0	0	0.01
	NF21	1,065	16	8	24	2.25	0	0.00	0	0.00	0	0	0	0.02
	NF22	1,230	0	0	0	0.00	0	0.00	0	0.00	0	0	0	0.00
	NF23	650	1	3	4	0.62	0	0.00	0	0.00	0	0	0	0.01
Teepee Creek	TP01	1,911	24	34	58	3.04	0	0.00	0	0.00	0	0	0	0.03
	TP02	5,306	0	0	0	0.00	0	0.00	0	0.00	0	0	0	0.00
	TP03	1,592	0	1	1	0.06	0	0.00	0	0.00	0	0	0	0.00
	TP04	2,839	3	7	10	0.35	0	0.00	0	0.00	0	0	0	0.00
	TP05	1,501	1	0	1	0.07	0	0.00	0	0.00	0	0	0	0.00
	TPR1	747	1	1	2	0.27	0	0.00	0	0.00	0	0	0	0.00
	TPR2	1,301	3	1	4	0.31	0	0.00	0	0.00	0	0	0	0.00

Table 28. Continued.

Reach	Transect	Area (m2)	Cutthroat Trout Number counted <300mm	Cutthroat Trout Number counted >300mm	Cutthroat Trout Total	Cutthroat Trout Density (No./100 m2)	Rainbow Trout Total	Rainbow Trout Density (No./100 m2)	Mountain Whitefish Total	Mountain Whitefish Density (No./100 m2)	Largescale Sucker Total	Northern Pikeminno Total	Brook Trout Total	Sal monid Density (No./100 m2)
Lower Little North Fork	LNF1	1,066	5	1	6	0.56	8	0.75	3	0.28	0	0	0	0.02
	LNF2	2,382	0	0	0	0.00	1	0.04	0	0.00	0	0	0	0.00
	LNF3	2,585	0	0	0	0.00	0	0.00	0	0.00	0	0	0	0.00
	LNF4	636	47	3	50	7.86	33	5.19	0	0.00	0	0	4	0.14
	LNF5	2,633	3	3	6	0.23	0	0.00	0	0.00	0	0	0	0.00
	LNF6	1,294	6	0	6	0.46	0	0.00	0	0.00	0	0	0	0.00
	LNF7	1,506	8	0	8	0.53	1	0.07	0	0.00	0	0	0	0.01
	LNF8	2,814	7	5	12	0.43	1	0.04	0	0.00	0	0	0	0.00
Upper Little North Fork	LNF9	737	0	0	0	0.00	0	0.00	0	0.00	0	0	0	0.00
	LNF10	1,617	14	0	14	0.87	0	0.00	0	0.00	0	0	1	0.01
	LNF11	1,418	1	0	1	0.07	0	0.00	0	0.00	0	0	0	0.00
	LNF12	694	26	0	26	3.74	0	0.00	0	0.00	0	0	0	0.04
	LNF13	863	14	2	16	1.85	0	0.00	0	0.00	0	0	0	0.02
TOTALS		**168,796**	**1,124**	**289**	**1,413**	**0.84**	**232**	**0.14**	**3685**	**2.18**	**726**	**935**	**5**	**3.16**

Table 29. Mean density (fish/100 m^2) of cutthroat trout (all sizes and only those ≥ 300 mm) counted in reaches of the North Fork Coeur d'Alene River (N.F. Cd'A), Little North Fork Coeur d'Alene River (L.N.F. Cd'A), and Tepee Creek, Idaho, during snorkel evaluations from 1973 to 2008.

All sizes of cutthroat trout

River section	1973	1980	1981	1987	1988	1991	1993	1994	1995	1996	1997	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008
N.F. Cd'A - S. F. Cd'A to Prichard Cr.	0.06	0.02	0.02	--	0.05	0.18	0.56	0.31	0.47	0.51	0.35	0.32	0.41	0.53	0.28	0.41	0.60	0.65	0.49	0.92	1.01
N.F. Cd'A - Prichard Cr to Yellowdog Cr.	0.05	0.00	0.02	--	0.02	0.14	0.08	0.28	0.19	0.06	0.44	0.41	0.13	0.51	0.49	0.30	0.33	0.66	0.67	0.58	0.46
N.F. Cd'A - Yellowdog Cr to Tepee Cr.	0.24	0.31	0.28	1.05	1.10	1.18	0.35	1.70	1.57	1.71	1.70	0.63	0.63	1.74	0.54	0.78	0.88	1.38	1.71	1.48	1.23
N.F. Cd'A - Tepee Cr. to Jordan Cr.	1.48	0.68	0.74	2.34	0.46	0.11	0.27	1.31	0.46	1.17	1.87	1.18	1.49	1.02	2.40	1.22	1.27	1.78	2.92	4.12	1.56
L.N.F. Cda - Mouth to Laverne Cr.	0.33	0.04	0.02	--	0.10	0.09	0.18	0.03	0.04	0.12	0.22	0.39	0.36	0.28	0.13	0.30	0.22	0.21	0.14	0.53	0.59
L.N.F. Cda - Laverne Cr. to Deception Cr.	0.79	1.03	1.95	--	0.90	0.66	0.03	0.47	0.22	0.90	0.00	0.65	0.79	0.12	0.98	0.69	0.97	1.35	0.56	2.26	1.07
Tepee Creek	0.00	0.14	0.43	0.24	0.12	0.24	0.19	0.12	0.13	0.02	0.45	1.24	0.25	0.24	0.84	0.44	0.85	0.54	1.00	1.14	0.53
Entire N.F. Cd'A River	0.13	0.10	0.11	--	0.33	0.32	0.35	0.54	0.53	0.63	0.69	0.44	0.38	0.76	0.43	0.47	0.58	0.82	0.86	1.05	0.89
Entire L.N.F. Cd'A River	0.38	0.15	0.24	--	0.27	0.20	0.15	0.13	0.09	0.35	0.17	0.45	0.45	0.25	0.31	0.39	0.44	0.56	0.27	1.06	0.72
All Transects	0.20	0.11	0.14	--	0.31	0.30	0.31	0.43	0.42	0.50	0.57	0.49	0.38	0.61	0.44	0.46	0.58	0.76	0.800	1.06	0.84
Historic Limited harvest areas	0.10	0.02	0.02	--	0.04	0.15	0.32	0.25	0.31	0.28	0.35	0.36	0.28	0.46	0.29	0.36	0.45	0.59	0.51	0.76	0.78
Historic Catch and release areas	0.51	0.41	0.53	1.09	0.81	0.76	0.25	0.94	0.72	0.90	1.08	0.89	0.65	1.05	0.89	0.73	0.92	1.23	1.56	1.75	1.03
Tepee Creek Rehab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.87	0.00	1.09	0.48	0.55	0.36	0.29

Cutthroat trout ≥ 300 mm

River section	1973	1980	1981	1987	1988	1991	1993	1994	1995	1996	1997	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008
N.F. Cd'A - S. F. Cd'A to Prichard Cr.	0.00	0.02	0.01	--	0.01	0.01	0.08	0.01	0.01	0.04	0.00	0.00	0.01	0.03	0.01	0.10	0.13	0.13	0.07	0.20	0.13
N.F. Cd'A - Prichard Cr to Yellowdog Cr.	0.00	0.00	0.00	--	0.01	0.03	0.02	0.04	0.01	0.01	0.01	0.03	0.01	0.06	0.04	0.09	0.09	0.24	0.21	0.19	0.18
N.F. Cd'A - Yellowdog Cr to Tepee Cr.	0.02	0.12	0.04	0.12	0.08	0.13	0.04	0.31	0.07	0.14	0.11	0.02	0.07	0.07	0.12	0.21	0.25	0.52	0.36	0.32	0.22
N.F. Cd'A - Tepee Cr. to Jordan Cr.	0.07	0.35	0.20	1.25	0.23	0.06	0.23	0.37	0.29	0.30	0.21	0.18	0.38	0.09	0.44	0.24	0.43	0.69	0.74	0.81	0.54
L.N.F. Cda - Mouth to Laverne Cr.	0.02	0.02	0.00	--	0.05	0.05	0.06	0.00	0.00	0.01	0.00	0.00	0.04	0.00	0.00	0.05	0.04	0.08	0.03	0.06	0.08
L.N.F. Cda - Laverne Cr. to Deception Cr.	0.18	0.37	0.18	--	0.09	0.00	0.03	0.00	0.00	0.05	0.00	0.00	0.06	0.00	0.11	0.15	0.18	0.16	0.07	0.22	0.04
Tepee Creek	0.00	0.03	0.43	0.20	0.06	0.18	0.08	0.09	0.09	0.00	0.08	0.08	0.05	0.04	0.22	0.16	0.34	0.05	0.29	0.30	0.32
Entire N.F. Cd'A River	0.01	0.05	0.02	--	0.04	0.04	0.06	0.08	0.03	0.07	0.03	0.02	0.04	0.05	0.05	0.12	0.15	0.24	0.19	0.24	0.17
Entire L.N.F. Cd'A River	0.03	0.05	0.02	--	0.06	0.04	0.06	0.00	0.00	0.02	0.00	0.00	0.04	0.00	0.02	0.07	0.08	0.10	0.04	0.11	0.07
All Transects	0.01	0.05	0.04	--	0.05	0.04	0.06	0.06	0.03	0.06	0.03	0.02	0.04	0.03	0.06	0.12	0.15	0.21	0.18	0.23	0.17
Historic Limited harvest areas	0.00	0.01	0.01	--	0.01	0.02	0.06	0.02	0.01	0.02	0.00	0.01	0.02	0.03	0.01	0.09	0.10	0.15	0.11	0.18	0.14
Historic Catch and release areas	0.04	0.17	0.15	0.33	0.10	0.11	0.07	0.20	0.10	0.12	0.10	0.06	0.11	0.06	0.18	0.19	0.28	0.37	0.36	0.35	0.27
Tepee Creek Rehab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.05	0.00	0.04	0.04	0.19	0.14	0.10

Table 30. Mean density (fish/100 m²) of all size classes of mountain whitefish counted in reaches of the North Fork Coeur d'Alene River (N.F. Cd'A), Little North Fork Coeur d'Alene River (L.N.F. Cd'A), and Tepee Creek, Idaho, during snorkel evaluations from 1973 to 2008.

River section	1973	1980	1981	1987	1988	1991	1993[5]	1994	1995	1996	1997	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008
N.F. Cd'A - S. F. Cd'A to Prichard Cr.	0.75	1.47	0.18	--	3.09	6.59	0.45	2.42	2.53	5.54	0.69	1.05	7.38	4.36	2.91	6.46	4.90	5.49	6.05	6.49	3.67
N.F. Cd'A - Prichard Cr to Yellowdog Cr.	0.46	0.02	0.12	--	0.03	1.25	0.29	0.65	0.11	1.13	0.56	0.58	0.23	0.20	0.32	0.83	0.73	2.04	1.48	1.11	1.13
N.F. Cd'A - Yellowdog Cr to Tepee Cr.	3.19	1.18	1.71	1.34	1.09	5.52	1.07	2.60	1.65	5.05	1.45	3.57	2.90	4.00	2.13	2.98	3.16	4.43	4.98	5.56	3.70
N.F. Cd'A - Tepee Cr. to Jordan Cr.	0.00	0.00	0.00	0.00	0.11	0.00	0.00	1.33	2.41	1.12	0.00	2.80	0.13	0.97	0.65	0.14	0.60	0.00	0.09	0.00	0.00
L.N.F. Cda - Mouth to Laverne Cr.	0.59	0.01	0.12	--	0.03	0	0	0	0	1.88	0	0.02	0	0.04	0.03	0.04	0.01	0.19	0.01	0	0.02
L.N.F. Cda - Laverne Cr. to Deception Cr.	0.00	0.00	0.00	--	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tepee Creek	0.00	0.35	0.00	0.00	0.00	0.00	0.06	0.00	0.00	2.68	0.00	0.20	0.36	1.09	0.91	0.63	1.04	0.43	1.41	1.42	0.00
Entire N.F. Cd'A River	1.00	0.80	0.39	--	1.21	4.07	0.46	1.86	1.70	3.52	0.72	1.35	3.46	3.43	2.33	3.95	3.06	4.21	4.26	4.55	2.76
Entire L.N.F. Cd'A River	0.52	0.01	0.11	--	0.02	0.00	0.00	0.00	0.00	1.34	0.00	0.02	0.00	0.03	0.02	0.03	0.01	0.13	0.01	0.00	0.01
All Transects	0.87	0.65	0.33	--	0.96	3.18	0.37	1.35	1.26	3.03	0.52	1.00	2.78	2.49	1.85	3.18	2.52	3.40	3.56	3.83	2.21
Historic Limited harvest areas	0.60	0.63	0.15	--	1.12	3.29	0.32	1.42	1.37	3.28	0.51	0.70	3.21	2.59	2.02	3.70	2.74	3.75	3.81	3.99	2.41
Historic Catch and release areas	1.77	0.71	0.95	0.80	0.64	2.86	0.52	1.14	0.97	2.61	0.53	1.93	1.53	2.20	1.35	1.73	1.93	2.43	2.91	3.45	1.62
Tepee Creek Rehab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 31. Mean density (fish/100 m²) of all size classes of rainbow trout counted in reaches of the North Fork Coeur d'Alene River (N.F. Cd'A), Little North Fork Coeur d'Alene River (L.N.F. Cd'A), and Tepee Creek, Idaho, during snorkel evaluations from 1973 to 2008.

River section	1973	1980	1981	1987	1988	1991	1993[5]	1994	1995	1996	1997	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008
N.F. Cd'A - S. F. Cd'A to Prichard Cr.	0.35	0.45	0.59	--	3.15	0.22	0.04	0.16	0.61	0.50	0.75	0.42	1.06	0.76	0.52	0.46	0.48	0.39	0.39	0.47	0.26
N.F. Cd'A - Prichard Cr to Yellowdog Cr.	0.48	0.12	0.46	--	0.14	0.20	0.01	0.08	0.14	0.02	0.12	0.06	0.03	0.11	0.00	0.01	0.08	0.06	0.09	0.21	0.01
N.F. Cd'A - Yellowdog Cr to Tepee Cr.	0.03	0.21	0.34	0.11	0.03	0.04	0.00	0.00	0.02	0.25	0.01	0.01	0.01	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
N.F. Cd'A - Tepee Cr. to Jordan Cr.	0.00	0.00	0.04	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L.N.F. Cda - Mouth to Laverne Cr.	1.39	0.55	1.25	--	1.6	0.99	0.22	0.45	0.02	0.09	0.24	0.54	0.35	0.18	0.46	0.27	0.09	0.17	0.12	0.08	0.30
L.N.F. Cda - Laverne Cr. to Burnt Cabin Cr	0.12	0.06	0.18	--	0.05	0.03	0.00	0.00	0.00	0.62	0.00	0.00	0.00	0.00	0.13	0.02	0.02	0.00	0.00	0.00	0.00
Tepee Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Entire N.F. Cd'A River	0.33	0.26	0.47	--	1.00	0.17	0.02	0.11	0.37	0.25	0.40	0.24	0.43	0.50	0.34	0.23	0.25	0.22	0.22	0.28	0.14
Entire L.N.F. Cd'A River	1.25	0.49	1.13	--	1.27	0.80	0.18	0.34	0.02	0.24	0.19	0.43	0.28	0.15	0.39	0.21	0.07	0.11	0.08	0.05	0.22
All Transects	0.46	0.29	0.56	--	0.99	0.27	0.04	0.14	0.28	0.22	0.32	0.27	0.38	0.39	0.33	0.21	0.21	0.19	0.19	0.24	0.14
Historic Limited harvest areas	0.59	0.34	0.66	--	1.49	0.35	0.05	0.19	0.37	0.25	0.46	0.35	0.51	0.51	0.43	0.29	0.29	0.27	0.26	0.34	0.19
Historic Catch and release areas	0.03	0.12	0.21	0.06	0.02	0.03	0.00	0.00	0.01	0.16	0.00	0.00	0.00	0.06	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Tepee Creek Rehab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.00	0.00	0.00	0.00	0.00	0.00

2008 Panhandle Region Fishery Management Report

HIGH MOUNTAIN LAKE INVESTIGATIONS

ABSTRACT

With the use of ArcGIS, we counted 138 mountain lakes in the Panhandle Region with an elevation of at least 1,000 m. This added 16 lakes to the existing 122 identified by Fredericks et al. (2002). We sampled a total of 51 lakes with experimental gill nets from June 30 to October 11, 2008. Surveyed lakes ranged from 846 to 2,233 m in elevation and 0.22 to 17.8 ha in size. Maximum depths of sampled lakes ranged from 1 to 29 m. Surface area estimates of several lakes in the stocking program were corrected based on the ArcGIS estimates. The new area estimates of all 51 regularly stocked lakes differed from the old estimates by approximately 4%. The change in area estimation resulted in the total number of requested fish dropping by only 5,800 to 123,900. Fish stocking records indicate that 51 or 37% of all mountain lakes within the Panhandle Region are currently being stocked on a 2-year cycle. However, gill netting surveys revealed an additional 17 lakes currently contain fish. Of the 17 additional lakes 14 (82%) contained brook trout while the remaining three (18%) contained cutthroat trout. Incorporating these additional populations increased the percentage of lakes containing fish to 49%. Of the 51 lakes sampled, eight had some level of natural reproduction of westslope cutthroat trout. Age of cutthroat trout at 250 mm ranged from 2.3 years in Sand Lake to 8.3 years in Little Ball Creek Lake. Lake by lake comparisons show that in a few of the lakes (n = 5) where stocking was significantly reduced, so did the age at which cutthroat achieved 250 mm. The mean age at 250 mm across the seven comparable lakes reduced significantly (p = 0.035) from 5.6 years to 4.0 years since the new program was implemented. Recommendations were made to conduct species specific stocking analysis for rainbow trout and Arctic grayling *Thymallus arcticus* in order to maximize growing potential. Amphibian species recorded during VES surveys included: Columbia spotted frogs *Rana luteiventris*, western toads *Bufo boreas*, and long-toed salamanders *Ambystoma macrodactylum*. Columbia spotted frogs were found in 29 (57%) sampled lakes. Western Toads were less common and were found in 8 (16%) sampled lakes. Long-toed salamanders were the least commonly recorded species found in just 6 (12%) of the total lakes sampled. In evaluation of the stocking model set up in 2000, we found a wide range of ages and growth rates in the surveyed lakes as we did in 1999. Bull trout were unexpectedly sampled in two of the Panhandle Lakes (Roman Nose #1 and Upper Glidden Lake) previously stocked in 1993 to reduce brook trout abundance and indirectly improve brook trout length at age. Results of the comparisons of brook trout growth revealed that all the lakes that still possess bull trout have significantly longer brook trout since the original stocking.

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INTRODUCTION

There are around 140 mountain lakes identified in North Idaho. IDFG currently stocks 51 of them to provide fishing opportunities for the public. Species stocked include westslope cutthroat trout, domestic Kamloops rainbow trout, golden trout *O. aguabonita* and Arctic grayling. Of the remaining un-stocked lakes (87), approximately 15-20 have known brook trout populations.

Fredericks et al. (2002) defined a "mountain lake" in the Panhandle Region as a water body over 1,000 m in elevation and at least 0.5 ha in size (Fredericks et al. 2002). We used a modified definition that includes all lakes over 1,000 m regardless of water body size (Meyer and Schill 2007). Although past assessments quantified the total number of lakes in the region, the redefinition of mountain lakes and the refinement of software such as ArcGIS will provide better estimates of the total number of lakes in the Panhandle Region.

The majority of lakes are stocked with rainbow and/or cutthroat trout fry on a 2-year cycle at target densities of approximately 750 fish/ha depending on lake elevation. This is a result of Fredericks et al. (2002) who found a strong relationship between fish growth and elevation and stocking density. Prior to Fredericks (2002) study, stocking rates in the Panhandle Region were generally on the upper end of the range used by other regions or found in literature (Der Hovanisian 1997). In many cases, stocking densities were much higher or lower than the target of 600 fish/ha, due to a lack of accurate size estimates on many lakes. Prior to 2000, mountain lake surveys indicated that stocking rates were generally sufficient to provide high yield fisheries. However, these surveys also demonstrated that most lakes had an abundance of older and smaller fish in the population, suggesting the lack of larger fish is more of a function of slow growth than the result of high exploitation (Fredericks et al. 2002). This lead to stocking densities being refined as a function of elevation, where higher elevation lakes would have the lowest stocking densities in order to maximize growing potential. Since the restructuring of the mountain lake stocking program were made in 2000, little information has been collected to determine if this refinement has improved fish growth in the Panhandle over the past eight years.

Based on stocking programs developed elsewhere, we believe that evaluating the efficacy of the stocking model adopted in the Panhandle to modify stocking rates by adjusting for abiotic factors such as elevation and productivity will aide in future decisions to fish maximize growing potential and the efficiency of the mountain lake stocking program.

A key element in evaluating stocking rates is to refine acreage estimates on all of the stocked mountain lakes. A large part of the "fine tuning" of the mountain lake stocking program in 2000 was accomplished by correcting erroneous surface area estimates with the use of a digital planimeter (Fredericks et al. 2002). With advances in technology since the last program refinement, the use of Arc GIS may provide more refined estimates of water body surface area specific to each mountain lake identified.

In corroboration with alpine lake management in the IDFG Five Year Fisheries Management Plan, IDFG has left many of the lakes in the Panhandle fishless to protect native fauna such as invertebrates and amphibians that utilize these lakes at some point in their life cycle. Recent research has indicated that a large portion of these lentic systems were historically fishless (Bahls 1992). While the introductions expanded recreational opportunities, researchers have since expressed concerns about the effects extensive fish stocking poses on native amphibian populations (Bahls 1992; Tyler et al. 1998; Knapp and Matthews 2000; Knapp et al. 2000; Pilliod and Peterson 2000; Pilliod and Peterson 2001; Murphy 2002). Conducting systematic surveys of mountain lakes in the Panhandle Region which are designed to enumerate amphibian density as well may better aide us in future stocking decisions. Currently, the IDFG is in the process of developing a comprehensive Alpine Lake Management Plan, which will encompass long term objectives of maximizing fishing opportunities for the public while at the same time maintaining a number of fishless lakes in every major drainage to protect native amphibian and invertebrate fauna.

OBJECTIVES

1. Identify any additional water bodies (minimum of 1,000 m in elevation and no size restriction), in order to refine the total number of stocked and un-stocked mountain lakes in the Panhandle Region.

2. Further refine existing surface area estimates of mountain lakes in the stocking program.

3. Evaluate whether fish stocking rates implemented in 2000 have helped optimize fish growth.

4. Identify those lakes with naturally producing populations of westslope cutthroat trout in both stocked and un-stocked mountain lakes.

METHODS

Enumeration and Area Estimation of Panhandle Region Mountain Lakes

We searched each digitized mountain lake layers of the Panhandle Region from the National Hydrography Dataset (NHD) with ArcGIS 9.3 at the 1:24,000 scale for water bodies above 1,000 m in elevation. We then utilized each layer's attribute tables to calculate surface area of each digitized lake polygon. When these parameters were not available we manually digitized each lake at the 1:2,500 scale to reduce any error in area estimation. We then categorized all lakes by major and minor drainage and recorded UTM latitude and longitude of each lake. We corrected the existing surface area estimates and adjusted stocking densities accordingly.

Fish and Amphibian Sampling of Panhandle Region Mountain Lakes

Fish Sampling

The presence of fish in study area lakes was determined using gill netting and visual observation techniques. Fish occurrence (presence/absence) was assessed using overnight gill net sets for approximately 12 hours. Gill nets were approximately 45.7 m in length made up of seven, 7.6 m panels. Mesh sizes of the various panels ranged from 25 to 100 mm. We recorded species, length and weight of all fish netted, and we collected otoliths for age analysis.

We categorically assessed the quality and quantity of spawning habitat in the inlets and outlets of lakes, and we recorded any observed spawning activity. Physical characteristics surveyed included the type of lake, aspect, and depth profile and inlet/outlet documentation. Chemical characteristics surveyed were TDS, conductivity, pH, and air and water temperature. The recreational use survey included the quality, and level of use of access and camping facilities.

Amphibian Sampling and Data Analysis

Amphibian surveys were conducted using a modified version of the visual encounter survey (VES) technique (Crump and Scott 1994; Schriever and Rhodes 2002). Our VES sampling was conducted by two trained observers who conducted a search of the entire perimeter of each sampled lake. Surveys were typically carried out between 10:00 and 16:00 hours while walking and wading along the lake shoreline. Amphibians were identified to species and classified within the following life stage classes: adult, sub-adult, larvae, egg mass.

We assessed whether amphibian occurrence and abundance was independent or related to fish presence (Sokal and Rohlf 1995). For this analysis we used Program R to perform chi-squared tests of independence (Funk and Dunlap 1999; Murphy 2002). Fish occurrence in lakes was determined using both stocking records and field survey data. Tests of independence were performed using the categories of lake status (containing fish/fishless) and amphibian occurrence. Tests of independence were also performed using lake status and amphibian abundance. For analysis purposes, as specified from Pilliod and Peterson 2001, lakes were excluded if air temperatures were below <10°C.

Evaluation of Stocking Model

Lake Selection

Fredericks et al. (2002) sampled 14 lakes in 1999 and used available data from two additional lakes surveyed in previous years. To evaluate the effectiveness of stocking recommendations set forth by the study, we re-sampled the 16 lakes. These lakes were originally selected utilizing the following criteria: 1) lakes without a reproducing population of brook trout, 2) lakes stocked with fry only (no catchables), and 3) lakes stocked primarily with cutthroat trout. We then located additional lakes clustered around these 16 lakes, for a total of 28 lakes. Contrary to the criteria in the 1998 study, lakes less than 0.5 ha in size were included in our study which increased the total number of lakes in the region to 138. These additional lakes were identified using ArcGIS. The remaining lakes were randomized by elevation (<1775 m, 1775 - 1850 m, and >1850 m), and clusters were selected to maximize sampling efficiency.

Stocking Model Evaluation

Fredericks et al. (2002) stocking model was based on the relationship between growth rates and measurable factors potentially affecting growth rates such as conductivity, elevation, and stocking density. Since conductivity explained less variation than elevation and stocking density it was dropped from the comparisons. The dependent variable tested was age-at-length. We used otolith analysis to estimate fish length-at-age, and then converted the relationship to estimate the age at which fish in the lake could be expected to achieve a length of 250 mm. In many of the lakes, we were able to validate the otolith age estimates by stocking records.

RESULTS

Enumeration of Panhandle Region Mountain Lakes

With the use of ArcGIS, we counted 138 mountain lakes in the Panhandle Region with an elevation of at least 1,000 m. This added 16 lakes to the existing 122 identified by Fredericks et al. (2002; Appendix A). Although Sand Lake (978 m) is below 1,000 m in elevation it is considered a mountain lake in our stocking schedule and fish growth analysis and therefore was added to the list.

Area Estimation

Surface area estimates of several lakes in the stocking program were corrected based on the ArcGIS estimates. There was no consistent trend to under or over-estimate area; however, comparison indicated that the existing area estimates of many lakes were marginally inaccurate (Table 32). The new area estimates of all 51 of the regularly stocked lakes differed from the old estimates by approximately 4%. Bacon Lake alone makes up 23% of the area correction. Although Bacon Lake was correctly re-analyzed for area estimation in 1999, the final change was omitted from the stocking request and as a result continues to be overstocked. The change in area estimation resulted in the total number of requested fish dropping by only 5,800 fish to 123,900 (Table 32). As a result of refining area estimations, adjustments were made to current stocking requests (Table 33).

Fish and Amphibian Sampling of Panhandle Region Mountain Lakes

We sampled a total of 51 lakes from June 30 to October 11, 2008. Surveyed lakes ranged from 846 to 2,233 m in elevation and 0.22 to 17.8 ha in size. Maximum depths of sampled lakes ranged from 1 to 29 m.

Fish stocking records indicate that 51 or 37% of all mountain lakes within the Panhandle Region are currently being stocked on a 2-year cycle. However, gill netting surveys revealed an additional 17 lakes that currently contain fish. Of the 17 additional lakes 14 (82%) contained brook trout while the remaining 3 (18%) contained cutthroat trout. In addition, two of these lakes contained a second species; bull trout and brown trout. Incorporating these additional populations increased the percentage of lakes containing fish to 49%.

Of the 51 lakes sampled, eight of them showed some level of natural reproduction of westslope cutthroat trout. Of those eight lakes, four are not currently being stocked with cutthroat (Little Ball, St. Joe, Lost, and Fish Lake). The additional four lakes (Harrison, Hidden, Larkins, and Spruce Lake) are currently being stocked, but are thought to have natural production as evident by observations of fry along with additional age classes identified in age analysis (Appendix B). Although we found spawning fish in several lakes, we believe successful reproduction was minimal. Most lakes had a notable lack of suitable habitat in inlets. Also, we found cutthroat trout spawning in mid-August, which suggests fry emergence and growth to a size sufficient to survive winter was unlikely in most lakes.

Of the lakes sampled with a long history of stocking of westslope cutthroat trout, two (Queen and Noseeum Lake) had no fish sampled (Appendix B). Comments on the report indicate no evidence of fish feeding on the surface during the survey.

Sampling took place in five of the six lakes currently stocked with Arctic grayling. Of these five, Arctic grayling were only present in two lakes (Crater and Steamboat Lake). Two of the lakes without Arctic grayling present, (Dismal and Lower Glidden Lake) are also stocked with rainbow trout, which were present in the sample (Appendix B). Little Ball Lake has been stocked with Arctic grayling since 2002; however, the only fish present in the sample were westslope cutthroat trout (last stocked in 1998). Golden trout were stocked into Little Ball Lake in 2008 in place of Arctic grayling.

Unexpectedly, bull trout were sampled in two of the Panhandle Lakes (Roman Nose #1 and Upper Glidden Lake) previously stocked in 1993 to reduce brook trout abundance and indirectly improve brook trout length-at-age. Due to overnight gill net sets, eight bull trout sampled were mortalities in Roman Nose Lake #1, yet allowed accurate age analysis. Ages ranged from 2 to 17 years indicating some level of natural reproduction occurring (Table 34). The oldest fish possessed an adipose clip indicating it was from the original stocking. Those sampled in Upper Glidden (n = 2) had adipose fins intact and were released. Genetic analysis from fin samples revealed that the fish in Roman Nose #1 were brook trout/ bull trout hybrids (except for the originally stocked fish), while those sampled in Upper Glidden were genetically pure bull trout (Table 34). Recent surveys from other regions that had the same program in place in 1993 also sampled bull trout. As a comparison to see how well the program actually worked to increase brook trout growth, lengths of brook trout from before bull trout stocking and then collected from most recent surveys were compared. Results of the comparisons revealed that all the lakes that still possess bull trout have significantly longer brook trout since the original stocking (Table 34). Those lakes that bull trout did not persist showed no difference. A control lake, Upper Stevens Lake, in the Panhandle that didn't get stocked with bull trout, also showed no significant increase in brook trout lengths. As a final comparison, Lake Estelle (last stocked with brown trout in 1992) still showed brown trout present in the 2008 sample. Brook trout lengths before and after the stocking periods also showed a significant increase (Table 34).

Amphibian species recorded during VES surveys included: Columbia spotted frogs, western toads, and long-toed salamanders. Columbia spotted frogs were found in 29 (57%) sampled lakes. Western Toads were less common and were found in 8 (16%) sampled lakes. Long-toed salamanders were the least commonly recorded species found in just 6 (12%) of the total lakes sampled (Table 35). Nineteen (37%) of the lakes surveyed contained no amphibians.

After excluding seven lakes due to cold air temperatures, 44 lakes were included in the amphibian analysis. Chi-squared tests of independence indicate that occurrences of all three amphibian species were independent of fish presence, supporting the null hypothesis. However, further analysis indicated that abundances of Columbia spotted frogs (p-value: 0.048) and long-toed salamanders (p-value: 0.040) were not independent of fish presence.

Stocking Model Evaluation

Similar to 1999, we found a wide range of ages and growth rates in the surveyed lakes. Age of cutthroat trout at 250 mm ranged from 2.3 years in Sand Lake to 8.3 years in Little Ball

Creek Lake (Table 36). Lake by lake comparisons show that in a few of the lakes (n = 5) where stocking was significantly reduced, so did the age at which cutthroat achieved 250 mm (Table 36; Figure 75). Although each lake should be considered a separate "treatment" since stocking densities changed differently for each, the mean age at 250 mm across the seven comparable lakes reduced significantly (p = 0.035) from 5.6 years to 4.0 years since the new program was implemented.

We conducted two simple linear regression analyses using age-at-250 mm as the dependent variable and stocking rate and elevation as the dependent variables. The coefficient of determination (r^2) for elevation was 0.47, indicating that around half of the variability in growth was related to elevation (Figure 76). Compared to 1999 (r^2 0.59) the trend in growth and elevation in 2008 is lower (Figure 76). When only regressing those lakes that had a direct before and after comparison of growth, the r^2 changed from 0.75 in 1999 to 0.62 in 2008 (Figure 77). The regression in stocking rates and age at 250 mm showed to have an inverse relationship in 2008 with an r^2 was 0.51, whereas in 1999 it was more of a direct relationship with an r^2 of 0.25 (Figure 78). This relationship reflects the changes in stocking density in relation to elevation (Table 37) that was established in 2000 by Fredericks et al. (2002).

DISCUSSION

Enumeration and Area Estimation

Based on our ArcGIS-based enumeration and summary, we are actively stocking only around 37% of the total number of mountain lakes (n = 138) in the region. Even with the new stocking criteria allowing all water bodies regardless of size to be incorporated, no unnamed water bodies were added at the list developed in 1999 (Fredericks at al. 2002). In further investigating the NHD layers in ArcGIS, many of these unnamed water bodies are currently not digitized, and therefore, did not make the random survey list. Although a meticulous process, future efforts need to update these layers to get a more refined number and area of alpine lakes in the Panhandle Region. Although we refined the lake areas, it only changed the current stocking request by 4%, indicating that the 1999 summary was fairly accurate. Without aerial photos, measurements are only as accurate as those available on the USGS topographical maps.

Fish and Amphibian Sampling of Panhandle Region Mountain Lakes

The 2008 surveys confirmed that some lakes contain naturally producing westslope cutthroat trout populations. In cases where we have been stocking on top of these populations, it is recommended that we further investigate total densities by year class in order to optimize growth. In a case of Little Ball Creek Lake, we were unaware there were naturally producing cutthroat following the discontinuation of stocking, and the stocking of Arctic grayling began. In 2008 no Arctic grayling were available and the lake was stocked with golden trout. In order to maximize the growing potential of westslope cutthroat in Little Ball Creek Lake, we recommend discontinuing Arctic grayling stocking. Arctic grayling were also shown to be absent from other lakes that have regularly been stocked with rainbow trout. It is possible that the presence of trout in an Arctic grayling stocked lake may be a factor in population viability.

The only evidence of winter-killed lakes were Queen and Noseeum Lakes. This is not surprising since the previous winter snowpack was above normal in this area and left many of these lakes covered in snow and ice for an extended period of time. Assuming that the lake is truly void of cutthroat trout, it may take several years (3-5) years until we see catchable size trout (250 mm) returning to the creel in these two lakes.

We did not expect to find bull trout still persisting in two of the Panhandle's mountain lakes. Under the appropriate conditions, bull trout regularly live to ten years (Bjornn 1961; McPhail and Murray 1979). The oldest one we sampled in 2008 was 17 years old in Roman Nose #1. Although the oldest bull trout recorded (24 years old) was from the upper North Thompson River, Fraser river system (Hagen and Baxter 1992), the one collected from our mountain lake was of a known age since it had an adipose clip and age validation performed on otoliths. We don't know whether bull trout survived this long because of abundant prey and a very cold, deep water body. In those lakes where bull trout did not persist, although they have adequate prey, their depth was relatively shallow. Length comparisons of brook trout before and after the stocking of bull trout are not surprising. However, the utility of using bull trout to increase the size of a stunted brook trout population is questionable since there was evidence of hybridization with brook trout. The unexpected persistence of these bull trout allows us to examine not only the long term efficacy of their original experiment on brook trout growth, but also the possible utility of these lakes as a "gene bank". Development of "gene banking" criteria and identification of at least one high mountain lake in each of the bull trout core areas that fits these criteria would be beneficial for accomplishing future bull trout management objectives.

Results from the chi-squared tests of independence indicate that the presence of all three amphibian species is independent of fish presence. However, tests also indicate that the abundances of Columbia spotted frogs and long-toed salamanders were significantly different between lakes with and without fish. These results are similar to findings from previous studies where fish presence was related to amphibian abundance but not occurrence; suggesting occurrence data alone does not provide adequate resolution for assessing fish-amphibian interactions (Pilliod and Peterson 2000, Murphy 2002). However, unlike many of these studies, the inference from our results is limited as amphibian habitat suitability was not accounted for in this study. While shallow, fishless lakes provide suitable breeding areas, amphibians face risks from desiccation in the summer along with freezing and anoxic conditions (Pilliod and Peterson 2001). Comparing lakes of similar habitat quality is a necessary step towards increasing the strength and inference of analysis results. Although the number of lakes with self-sustaining populations of fish (primarily brook trout) is not exact, the summary indicates that IDFG has left many lakes fishless. Recent years have seen an increase in concerns relating to the impact of introduced fish on native fauna--particularly fish, amphibians, and invertebrates (Horton and Ronayne 1995; Bahls 1990). The importance of leaving a portion of the state's mountain lakes fishless has been recognized and is specified as a guiding principle in the 2007-2012 Fisheries Management Plan (IDFG 2007). We believe the mountain lake stocking program in the Panhandle Region is consistent with IDFG objectives for preserving healthy native fauna.

Stocking Model Evaluation

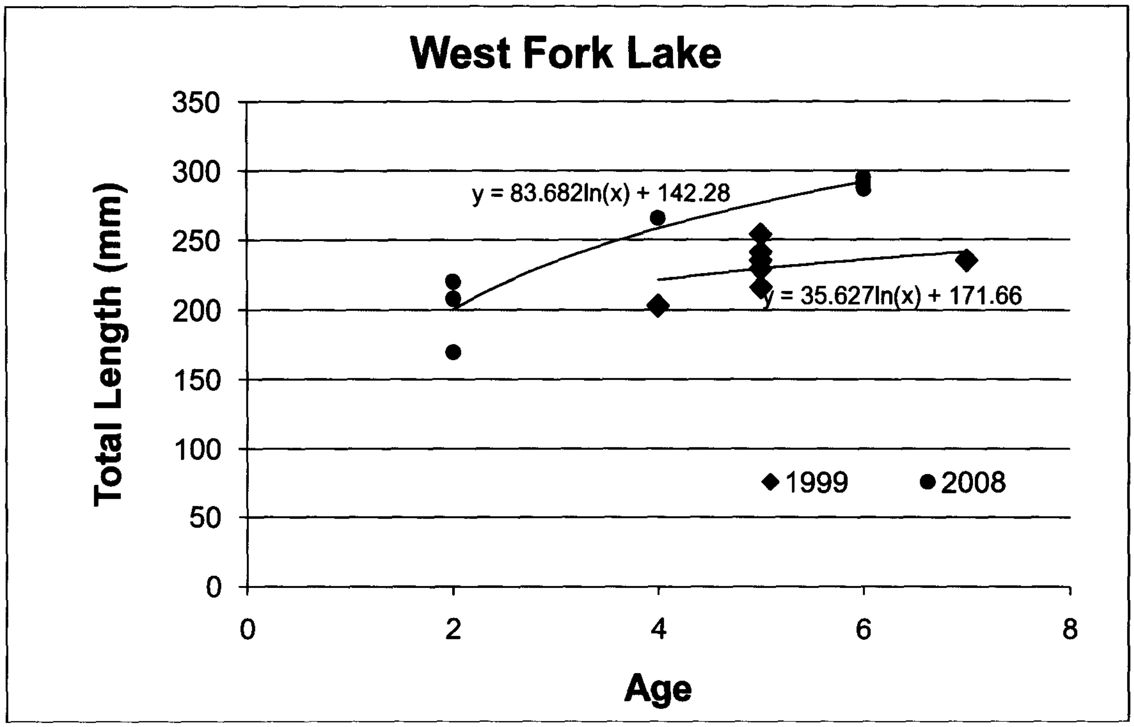
We believe the stocking guidelines developed by Fredericks et al. (2002) improved the quality and efficiency of the mountain lake fish-stocking program. Although there are other factors acting on growth that can limit the models utility (such as natural reproduction or excessive angling pressure) the model seemed to provide adequate densities (based on elevation) to optimize trout growth. Nelson (1988) concluded that stocking rates should be adjusted for elevation and angling pressure, and where possible, alkalinity. In general, he recommended a 28% decrease in stocking rate for each increase in elevation of 305 m. The only metric available for angling pressure was accessibility and therefore it was left out of the model (Fredericks et al. 2002). In the future, a better idea of how to survey these lakes for angling pressure should be explored.

We recognize that the relationship between elevation and growth is also a function of growing season and temperature. This is evident in the fact that stocking rates only reduced the age at 250 mm so far. At some point, no matter how we change stocking densities, elevation will be the dominant factor predicting fish growth especially in high elevation lakes.

An evaluation of regional lakes stocked with Arctic grayling and golden trout in the near future would be valuable in assessing stocking rates for these species. Finally, if sterile rainbow trout will be used on a broad scale to replace fertile rainbow and cutthroat trout in regional mountain lakes, a similar analysis which utilizes their unique growth rates and longevity should eventually be completed.

MANAGEMENT RECOMMENDATIONS

1. Change stocking schedule to reflect new lake area estimates.
2. Use ArcGIS software in the future to further refine total mountain lake numbers.
3. Discontinue stocking of Arctic grayling and golden trout in Little Ball Creek Lake.
4. Conduct species specific stocking analyses for sterile rainbow trout and grayling.
5. Develop "gene banking" criteria for bull trout in mountain lakes.



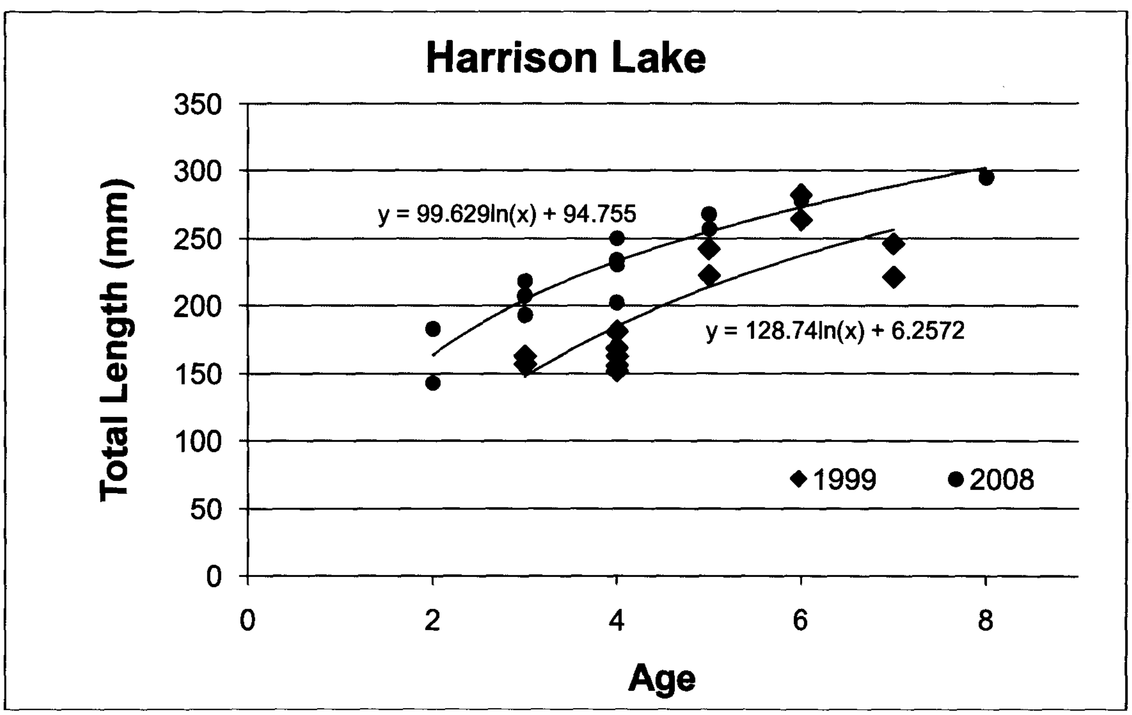


Figure 75. Comparison of growth rates of cutthroat trout in two high mountain lakes before (1999) changes in stocking density and 8 years after (2008) changes were made. Lines were fit using a non-linear exponential regression (1999 data from Fredericks et al. 2002).

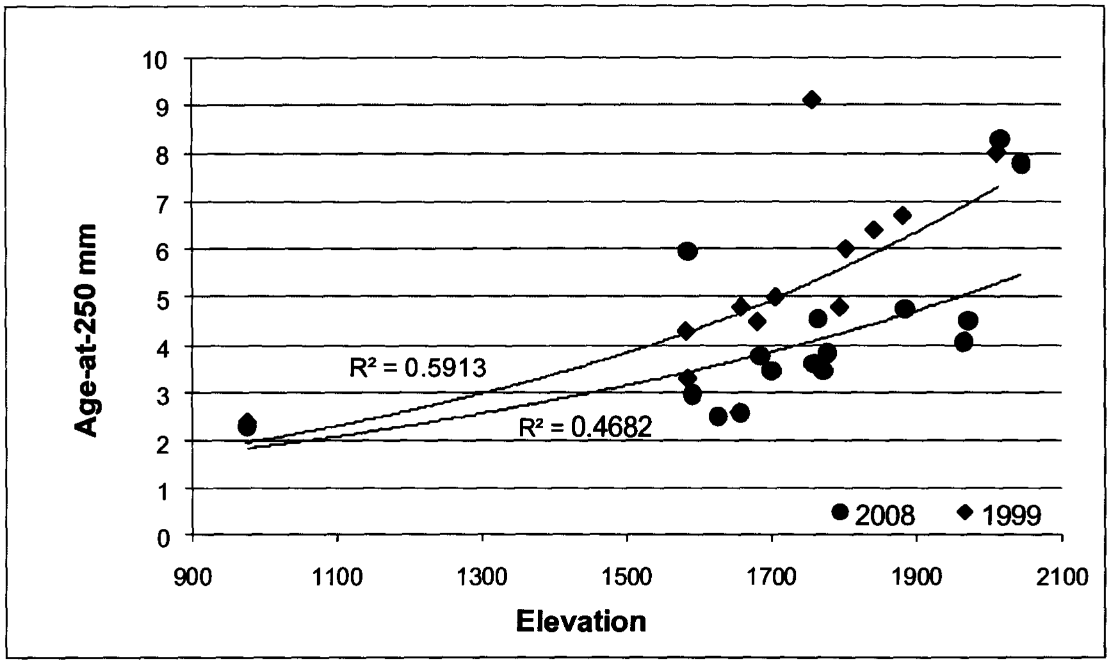


Figure 76. Comparison of the relationship between elevation (m above msl) and cutthroat trout growth rates in high mountain lakes before (1999) changes in stocking density and 8 years after (2008) changes were made. Lines were fit using a non-linear exponential regression (1999 data from Fredericks et al. 2002).

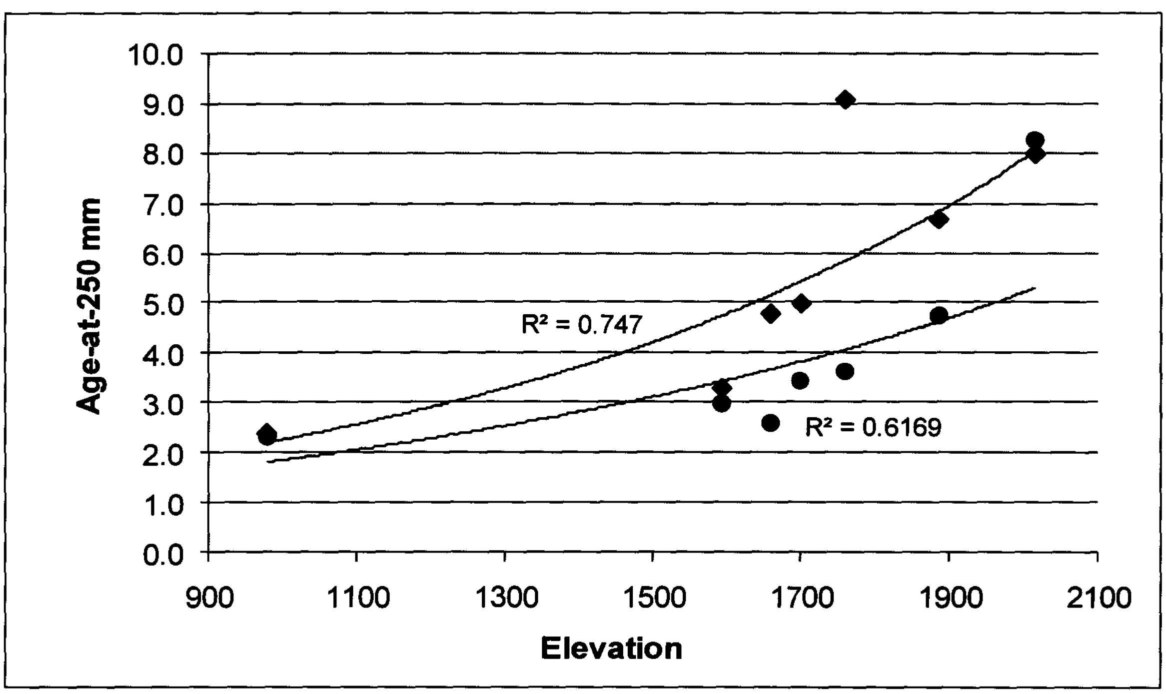


Figure 77. Comparison of the relationship between elevation (m above msl) and cutthroat trout growth rates in 7 specific high mountain lakes before (1999) changes in stocking density and 8 years after (2008) changes were made. Lines were fit using a non-linear exponential regression (1999 data from Fredericks et al. 2002).

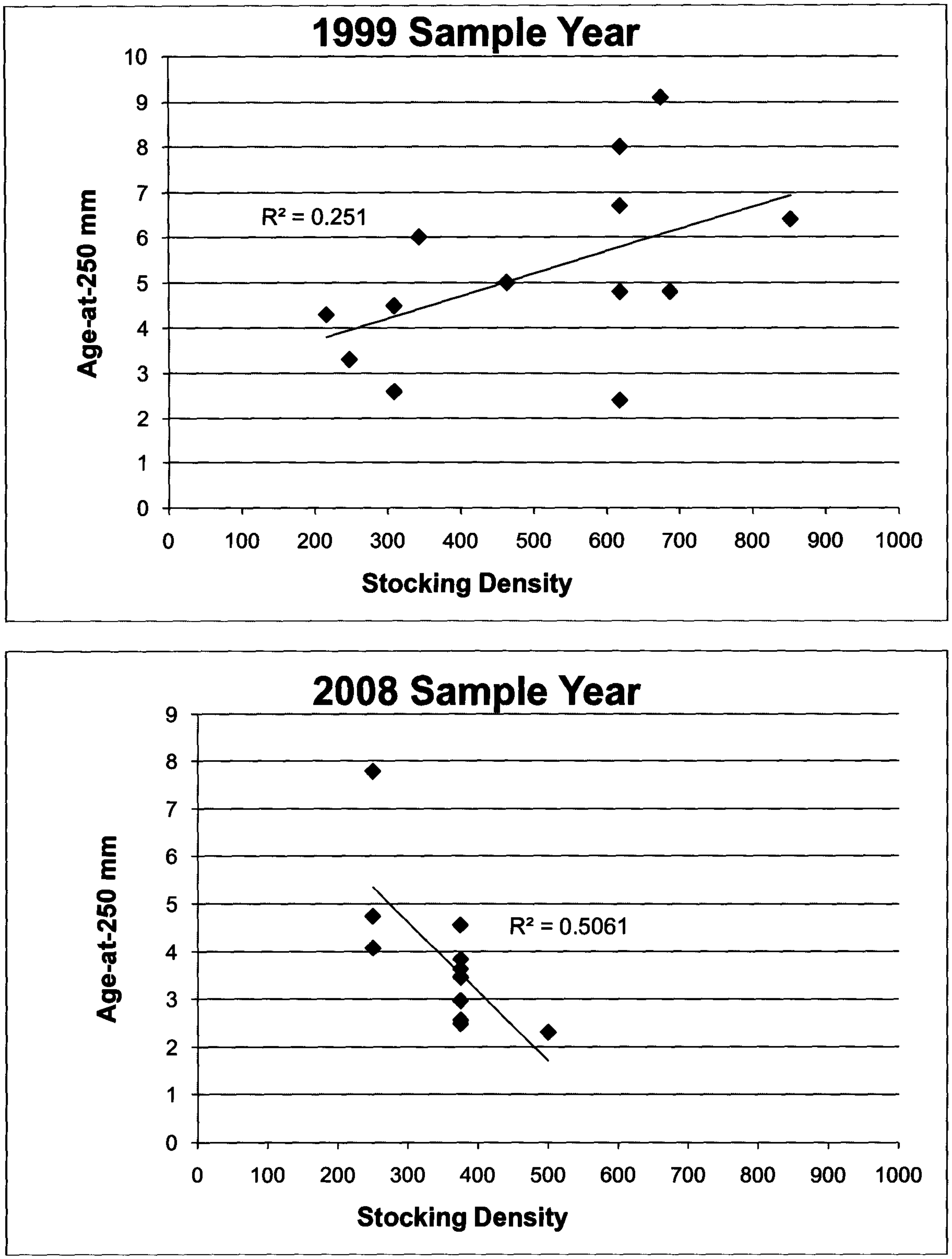


Figure 78. Comparison of the relationship between stocking density (fish/ha) and cutthroat trout growth in high mountain lakes before (1999) changes in stocking density and 8 years after (2008) changes were made. Lines were fit using a non-linear exponential regression (1999 data from Fredericks et al. 2002).

Table 32. Current and modified (2008) stocking densities in the Panhandle Region, Idaho mountain lakes.

Lake	Current Area (ha)	2008 GIS Modified Area (ha)	Current Estimated Density (fish/ha)	2008 Estimated Density (fish/ha)	Current Request	Recommended Request	Stocking year
Kootenai Drainage							
Hidden	18.22	17.82	741	758	13,500	13,200	Even
Lake Mtn (Cuttoff)	2.02	2.13	494	470	1,000	1,000	Even
West Fork	4.45	4.23	741	781	3,300	3,100	Even
Long Mountain	0.81	0.74	1235	1346	1,000	900	Even
Parker	1.62	1.77	494	451	800	900	Even
Long Canyon	2.02	1.84	1235	1357	2,500	2,300	Even
Big Fisher	3.64	3.86	494	467	1,800	1,900	Even
Myrtle	8.10	7.98	741	751	6,000	6,000	Even
Trout	2.83	2.68	494	523	1,400	1,300	Even
Pyramid	3.24	3.05	494	524	1,600	1,500	Even
Ball	2.43	2.68	494	448	1,200	1,300	Even
Little Ball	0.81	0.57	1235	1741	1,000	700	Even
Snow	3.64	3.35	741	805	2,700	2,500	Even
Roman Nose #3	4.86	4.32	741	833	3,600	3,200	Even
Queen	1.21	0.98	741	921	900	700	Even
Debt	1.21	0.89	741	1016	900	700	Even
Spruce	2.02	2.59	741	578	1,500	1,900	Even
Copper	0.81	0.54	741	1107	600	400	Even
Callahan	3.24	3.20	1235	1249	4,000	4,000	Even
Pend Oreille Drainage							
Hunt	5.67	5.63	741	747	4,200	4,200	Even
Standard	5.26	5.37	741	726	3,900	4,000	Even
Two Mouth #2	3.24	3.23	494	495	1,600	1,600	Even
Two Mouth #3	1.62	1.39	741	865	1,200	1,000	Even
Mollies	0.81	0.77	741	779	600	600	Even
Fault (Hunt Pk #1)	2.43	2.36	617.5	635	1,500	1,500	Even
McCormick (Hunt Pk #2)	1.21	1.16	494	515	600	600	Even
Little Harrison	2.83	2.37	494	592	1,400	1,200	Even
Beehive	2.43	2.41	494	497	1,200	1,200	Even
Harrison	11.74	11.54	494	502	5,800	5,700	Even
Dennick	3.24	2.69	1235	1488	4,000	3,300	Even
Sand	2.02	1.98	1235	1265	2,500	2,400	Even
Caribou (Keokee Mtn)	2.83	2.30	741	913	2,100	1,700	Even
Spokane Drainage							
Lower Glidden	5.67	5.60	494	500	2,800	2,800	Even
Gold	1.21	1.46	741	616	900	1,100	Even
Crater	1.62	1.53	1235	1308	2,000	1,900	Odd
Dismal	2.43	2.56	494	469	1,200	1,200	Odd
Bacon	3.64	2.08	741	1298	2,700	1,500	Odd
Forage	2.83	2.89	741	727	2,100	2,100	Odd
Halo	4.05	4.07	494	491	2,000	2,000	Odd
Crystal	4.05	3.83	741	784	3,000	2,800	Even

Table 32. Continued.

Lake	Current Area (ha)	2008 GIS Modified Area (ha)	Current Estimated Density (fish/ha)	2008 Estimated Density (fish/ha)	Current Request	Recommended 2008 Change in Requested	Stocking year
Little North Fork Clearwater Drainage							
Devils Club	1.21	1.12	741	805	900	800	Odd
Big Talk	2.02	1.95	741	769	1,500	1,400	Odd
Larkins	3.24	3.20	741	749	2,400	2,400	Odd
Mud	2.02	1.63	741	922	1,500	1,200	Odd
Hero	2.02	2.04	741	737	1,500	1,500	Odd
Heart	13.36	13.03	494	507	6,600	6,400	Odd
Northbound	4.86	4.65	741	774	3,600	3,400	Odd
Skyland	5.26	5.20	1235	1249	6,500	6,400	Odd
Fawn	5.26	4.76	741	819	3,900	3,500	Odd
No-see-um	1.62	1.97	741	610	1,200	1,400	Odd
Steamboat	2.83	2.95	1235	1187	3,500	3,600	Odd
Sum of Number Requested							
Odd year					43,100	40,700	
Even year					86,600	83,200	
Total					129,700	123,900	

Table 33. Recommended stocking schedule for mountain lakes of the Panhandle Region, Idaho.

Lake	Code	Surface acres	Number requested	Species	Substitute species	Stocking year
Kootenai Drainage						
Hidden	01-103	45	13,200	KT	C2	Even
Lake Mtn (Cuttoff)	01-104	5	1,000	C2	KT	Even
West Fork	01-109	11	3,100	C2	KT	Even
Long Mountain	01-112	2	900	GR	None	Even
Parker	01-113	4	900	GN	GR	Even
Long Canyon	01-115	5	2,300	GN	GR	Even
Big Fisher	01-117	9	1,900	C2	KT	Even
Myrtle	01-122	20	6,000	C2	KT	Even
Trout	01-124	7	1,300	KT	C2	Even
Pyramid	01-125	8	1,500	KT	C2	Even
Ball	01-126	6	1,300	C2	KT	Even
Little Ball	01-127	2	Discontinue stocking GR			
Snow	01-134	9	2,500	C2	KT	Even
Roman Nose #3	01-137	12	3,200	KT	C2	Even
Queen	01-148	3	700	C2	KT	Even
Debt	01-157	3	700	C2	KT	Even
Spruce	01-147	5	1,900	KT	C2	Even
Copper	01-155	2	400	C2	KT	Even
Callahan	01-166	8	4,000	GR	None	Even
Pend Oreille Drainage						
Hunt	02-101	14	4,200	C2	KT	Even
Standard	02-103	13	4,000	C2	KT	Even
Two Mouth #2	02-107	4	1,600	C2	KT	Even
Two Mouth #3	02-108	8	1,000	C2	KT	Even
Mollies	02-114	2	600	C2	KT	Even
Fault (Hunt Pk #1)	02-121	6	1,500	C2	KT	Even
McCormick (Hunt Pk #2)	02-122	3	600	C2	KT	Even
Little Harrison	02-126	7	1,200	C2	KT	Even
Beehive	02-128	6	1,200	C2	KT	Even
Harrison	02-129	29	5,700	C2	KT	Even
Dennick	02-171	8	3,300	C2	KT	Even
Sand	02-172	5	2,400	C2	KT	Even
Caribou (Keokee Mtn)	02-196	7	1,700	C2	KT	Even

Table 33. Continued.

Lake	Code	Surface acres	Number requested	Species	Substitute species	Stocking year
Spokane Drainage						
Lower Glidden	03-123	14	2,800	GR	None	Even
Gold	03-125	3	1,100	KT	None	Even
Crater	03-133	4	1,900	GR	None	Odd
Dismal	03-138	6	1,200	GR	None	Odd
Bacon	03-144	9	1,500	C2	KT	Odd
Forage	03-146	7	2,100	GN	GR	Odd
Halo	03-147	10	2,000	C2	KT	Odd
Crystal	03-060	10	2,800	C2	KT	Even
Little North Fork Clearwater Drainage						
Devils Club	06-113	3	800	C2	KT	Odd
Big Talk	06-114	5	1,400	C2	KT	Odd
Larkins	06-117	8	2,400	C2	KT	Odd
Mud	06-118	5	1,200	KT	C2	Odd
Hero	06-119	5	1,500	C2	KT	Odd
Heart	06-122	33	6,400	KT	None	Odd
Northbound	06-123	12	3,400	C2	KT	Odd
Skyland	06-125	13	6,400	KT	None	Odd
Fawn	06-126	13	3,500	C2	KT	Odd
No-see-um	06-130	4	1,400	C2	KT	Odd
Steamboat	06-131	7	3,600	GR	None	Odd

Sum of Number Requested

	C2	K1	GR	GN	Total
Odd year	17,900	14,000	6,700	2,100	40,700
Even year	49,400	22,200	7,700	3,200	82,500
Total	67,300	36,200	14,400	5,300	123,200

Table 34. Brook trout lengths following stocking of bull and brown trout in select high mountain lakes in the Panhandle, Idaho. Age validation on bull trout was performed by reading cross sectioned otoliths from mortalities. Genetic testing was performed on caudal fin tissue samples collected in the field in 2008.

Lake Name	Region	Species Stocked	Stocking Year	Year BLT Last Sampled	Mean BKT TL (mm) Before Stocking	Mean BKT TL (mm) After Stocking	*p*-value from Anova Test on BKT TL Change	BLT Natural Production	BLT Genotype	BLT Age Range
Revett Lake	Panhandle	bull trout	1993	none samp	183.6	182.8	0.880	unknown	NA	NA
Roman Nose Lake #1	Panhandle	bull trout	1993	2008	[redacted]			yes	hybridization	8 - 17
Roman Nose Lake #2	Panhandle	bull trout	1993	none samp	177.4	179.1	0.685	unknown	NA	NA
Upper Glidden Lake	Panhandle	bull trout	1993	2008	[redacted]			yes	pure bull trout	NA
Toxaway Lake	Salmon	bull trout	1993	2007				yes	unknown	NA
Upper Hazard Lake	Southwest	bull trout	1993	2005	NA	227.4	NA	unknown	unknown	NA
Lake Estelle	Panhandle	brown trout	1988/90/92	2008	[redacted]			yes	unknown	
Upper Stevens Lake	Panhandle	Not Stocked (used as a control lake)			185.3	191.6	0.296	NA	NA	

Table 35. Amphibians observed during visual encounter surveys in 2008 from mountain lakes in the Panhandle Region.

		Amphibians Observed		
Date Sampled	**Lake Name**	**CSF**	**WT**	**LTS**
9/4/2008	Dennick Lake	X		
6/3/2008	Sand Lake	X		
9/3/2008	Beaver Lake	X		
7/7/2008	West Fork Smith Creek Pond #X	X	X	
8/5/2008	Elsie Lake	X		
7/22/2008	Caribou Lake (Pack)	X		
9/8/2008	Dismal Lake	X		
8/13/2008	Hero Lake	X		X
7/8/2008	Darling Lake	X	X	
7/22/2008	Spruce Lake	X		
7/8/2008	Hidden Lake		X	
9/15/2008	Moose Lake		X	
7/16/2008	Bottleneck Lake	X		
7/28/2008	Larkins Lake	X		X
8/4/2008	Lower Glidden Lake	X		
7/15/2008	West Fork Lake	X	X	
1/11/2008	Crater Lake	X		
7/14/2008	Snow Lake	X		
7/8/2008	Roman Nose Lake 3		X	
7/23/2008	Copper Lake	X		
7/9/2008	Roman Nose Lake 2	X		
7/29/2008	Steamboat Lake	X		X
9/17/2008	Gem Lake	X	X	
8/4/2008	Pyramid Lake	X		
7/28/2008	No-see-um Lake	X		X
9/2/2008	Queen Lake	X		
7/9/2008	Joe Lake	X	X	
8/1/2008	Lookout Lake	X		
9/29/2008	Theiralt Lake	X		X
9/3/2008	Little Lost Lake	X		
7/16/2008	West Fork Smith Lake	X		
8/12/2008	Gnat Lake	X		X
	Total Number of Lakes Per Species:	29	8	6

Legend: CFS – Columbia spotted frog
WT – Western toad
LTS – Long toed salamander

Table 36. Length and growth characteristics of westslope cutthroat trout collected in 1999 and 2008 from mountain lakes in the Panhandle Region, Idaho. Shaded cells indicate an increase in growth rate with a change in stocking density.

		Size of fish collected		Age of fish collected				
Lake Name	Elevation (m)	Mean TL (mm)	Max TL (mm)	Max Age	2008 Age @ 250mm	1999 Age @ 250mm	Current Stocking Density (fish/ha)	Historical Stocking Density (fish/ha)
Upper Ball	2,045	222.5	265.0	8.0	7.8		250	309
Little Ball	2,016	214.2	251.0	7.0	8.3	8.0	NA	618
St. Joe Lake	1,973	260.0	312.0	7.0	4.5		NA	NA
Beehive	1,966	249.1	295.0	6.0	4.1		250	361
Harrison	1,886	227.9	312.0	8.0	4.8	6.7	250	618
Pyramid	1,847	NA	NA	NA	NA	6.4	250	853
Copper	1,804	240.5	242.0	2.0	NA (1 age class)	NA	375	1029
Roman Nose #3	1,794	247.0	247.0	4.0	NA (n=1)	4.8	375	625
Two Mouth #2	1,780	267.1	315.0	6.0	3.8		375	387
Hunt	1,773	273.5	315.0	6.0	3.5		375	531
Snow	1,767	244.9	285.0	6.0	4.6	NA	375	344
W.F. Lake	1,760	253.5	295.0	6.0	3.6	9.1	375	675
Larkins	1,701	296.7	344.0	5.0	3.5	5.0	375	464
Lost	1,686	294.1	355.0	7.0	3.8		NA	NA
Hidden	1,659	320.3	375.0	6.0	2.6	3.5	375	687
Noseeum	1,633	NA	NA	NA	NA	4.5	375	309
Spruce	1,627	342.3	395.0	5.0	2.5	NA	375	618
Standard	1,622	234.7	250.0	4.0	NA (1 age class)		375	380.5
Hero	1,593	291.4	355.0	7.0	3.0	3.3	375	250
Fish	1,586	215.3	285.0	7.0	5.9		NA	NA
Caribou (Pack)	1,583	311.8	321.0	6.0	NA (1 age class)	4.3	500	618
Sand	978	364.2	438.0	4.0	2.3	2.4	500	618
Dennick	846	248.5	255	2	NA (1 age class)		500	618

Table 37. Current stocking rates for cutthroat trout fry based on elevation and surface area in mountain lakes of the Panhandle Region, Idaho (from Fredericks et al. 2002).

Elevation (m above m.s.l.)	Density (fry/ha on alternate years)
Over 1,830 m	500
1,525-1,830 m	750
1,000-1,525 m	1,000

LITERATURE CITED

Abbott, A.M. 2000. Land management and flood effects on the distribution and abundance of cutthroat trout in the Coeur d'Alene River basin, Idaho. Masters Thesis, University of Idaho. Moscow.

Anderson, D.R., and K.P. Burnham, and W.L. Thompson. 2000. Null Hypothesis Testing, Prevalence, and an Alternative. Journal of Wildlife Management 64:912-923.

Anderson, R.O. 1980. Proportional stock density (PSD) and relative weight (Wr): Interpretive indices for fish populations and communities. Pages 27-33 in S. Gloss and B. Shupp, editors. Practical fisheries management: more with less in the 1980's. Workshop proceedings, New York Chapter, American Fisheries Society, Ithaca, New York, USA.

Anderson, R.O. and R.M. Neumann 1996. Passive capture techniques. Pages 95-122. *In* B.R. Murphy and D.W. Willis [eds]. Fisheries Techniques. American Fisheries Society. Bethesda.

Bahls, P.F. 1990. Ecological implications of trout introductions to lakes of the Selway-Bitterroot Wilderness, Idaho. Master's Thesis. Oregon State University, Corvallis.

Bahls, P.F. 1992. The status of fish populations and management of high mountain lakes in the western United States. Northwest Science. 66(3):183-193.

Baxter, J.S., and W.T. Westover. 1999. Wigwam River bull trout. Habitat Conservation Trust Fund Progress Report (1998). Fisheries Progress Report K054. British Columbia Ministry of Environment, Cranbrook.

Bjornn, T.C. 1957. A survey of the fishery resources of Priest and Upper Priest Lakes and their tributaries. Completion Report F-24-R. Idaho Department of Fish and Game. Boise.

Blackwell, B.G., M.L. Brown, and D.W. Willis. 2000. Relative weight (Wr) status and Current use in fisheries assessment and management. Reviews in Fisheries Science 8: 1-44.

Bonneau, J.L. and G. LaBar. 1997. Inter-observer and temporal bull trout redd count variability in tributaries of Lake Pend Oreille, Idaho. Department of Fish and Wildlife Resources, University of Idaho, Moscow, Idaho 83844-1136.

Bowler, B. 1974. Coeur d'Alene River Study. Idaho Department of Fish and Game. Federal Aid in Fish Restoration. F-53-R-9. Job Performance Report. Boise.

Bowler, B., B.E. Rieman, and V.L. Ellis. 1979. Pend Oreille Lake fisheries investigations. Idaho Department of Fish and Game. Job Performance Report. Project F-73-R-1. Boise.

Crump, M.A. and N.J. Scott Jr. 1994. Visual Encounter Surveys. Pages 84 – 92 *in* Heyer, W.R., M.A. Donnelly, R.W. McDiarmid, L.C. Hayek and M.S. Foster, editors. 1994. Measuring and monitoring biological diversity: standard methods for amphibians. Smithsonian Institution Press, Washington.

Davis, J.A., L. Nelson, N. Horner. 1992. Idaho Department of Fish and Game. Job Performance Report. Program F-71-R-17. Boise.

Davis, J.A., L. Nelson, N. Horner. 1994. Idaho Department of Fish and Game. Job Performance Report. Program F-71-R-19. Boise.

Deleray, M., L. Knotek, S. Rumsey, and T. Weaver. 1999. Flathead Lake and River system fisheries status report. Montana Fish, Wildlife and Parks, Kalispell.

Der Hovanisian, J.A. 1997. Synopsis of nationwide strategies for high mountain lake management. Federal Aid in Fish Restoration. Job Performance Report Project F-73-R-18. Idaho Department Fish and Game. Boise.

DeVries, P.E. 2000. Scour in low gradient gravel bed streams: Patterns, processes, and implications for the survival of salmonid embryos. Doctoral Dissertation. University of Washington. Seattle.

Downs, C.C., and R. Jakubowski. 2003. Lake Pend Oreille/Clark Fork River fishery research and monitoring, 2002 Progress Report. Project 5, 2000-2002 Trestle and Twin Creeks bull trout outmigration and Lake Pend Oreille survival study progress report. Avista Corporation. Spokane, Washington.

Downs, C.C., and R. Jakubowski. 2006. Lake Pend Oreille/Clark Fork River fishery research and monitoring, 2005 Progress Report. Project 1, 2005 Lake Pend Oreille bull trout counts progress report. Avista Corporation. Spokane, Washington.

Donald, D. B., and Alger. 1993. Geographic distribution, species displacement, and niche overlap for lake trout and bull trout in mountain lakes. Canadian Journal of Zoology 71: 238-247.

Dunham J.B., B.E. Rieman, and K. Davis. 2001. Sources and magnitude of sampling error in redd counts for bull trout. North American Journal of Fish Management 21:343-352.

Dunn, C. 1968. St. Joe River Creel Census – 1968. Idaho Cooperative Fishery Unit, Completion Report, University of Idaho, Moscow.

DuPont J., M. Liter, and N. Horner. In Press. Regional fisheries management investigations. Idaho Department of Fish and Game. Federal Aid in Fish Restoration. F-71-R-29. Job Performance Report. Boise.

DuPont, J., M. Liter, and N. Horner. In Press. Regional fisheries management investigations. Idaho Department of Fish and Game. Federal Aid in Fish Restoration. Upper Priest River Bull Trout Redd Surveys. Job Performance Report. Boise.

DuPont, J., M. Liter, and N. Horner. 2006. Regional fisheries management investigations. Idaho Department of Fish and Game. Federal Aid in Fish Restoration. F-71-R-27. Job Performance Report. Boise.

DuPont J., M. Liter, and N. Horner. 2008. Regional fisheries management investigations. Idaho Department of Fish and Game. Federal Aid in Fish Restoration. Job Performance Report. IDFG 07-57. Boise.

DuPont, J., M. Liter, and N. Horner. In Press. Regional fisheries management investigations. Idaho Department of Fish and Game. Federal Aid in Fish Restoration. Use of Side Channel Habitat by Cutthroat Trout. Job Performance Report. Boise.

DuPont, J., M. Liter, and N. Horner. 2008. Regional fisheries management investigations. Idaho Department of Fish and Game. Federal Aid in Fish Restoration. Movement, Mortality and Habitat Use of Coeur d'Alene River Cutthroat Trout. Job Performance Report. Boise.

DuPont, J., M. Liter, and N. Horner. 2009. Regional fisheries management investigations. Idaho Department of Fish and Game. Federal Aid in Fish Restoration. St. Joe River and North Fork Coeur d'Alene River Snorkel Surveys. Job Performance Report IDFG 09-109. Boise.

Fraley, J., and B. Shepard. 1998. Life history, ecology, and population status of migratory bull trout (Salvelinus confluentus) in the Flathead Lake and River system, Montana. Montana Department of Fish, Wildlife, and Parks, Kalispell.

Fredenberg, W. 2002. Further evidence that lake trout displace bull trout in mountain lakes. Intermountain Journal of Sciences 8(3).

Fredericks, J. 1998. Idaho Department of Fish and Game Job Performance Report. Program F-71-R-23. Boise.

Fredericks, J. and J. Venard. 1999. Bull trout exotic fish removal project completion report. Threatened and Endangered Species Report, Project E-20:1-3. Section 6, Endangered Species Act, 2001.

Fredericks, J., J. Davis, N. Horner, and C. Corsi. 2002. Regional fisheries management investigations. Idaho Department of Fish and Game. Federal Aid in Fish Restoration. F-71-R-23 Job Performance Report. Boise.

Fredericks, J. and N. Horner. 2002. Mountain lakes investigations. Idaho Department of Fish and Game. Job Performance Report. Project F-71-R-24. Boise.

Fredericks, J. and N. Horner. 2003. Lowland lakes investigations. Idaho Department of Fish and Game. Job Performance Report. IDFG 02-53 Boise.

Funk, C.W., and W.W. Dunlap. 1999. Colonization of high-elevation lakes by long-toed salamanders (Abystoma macrodactylum) after extinction of introduced trout populations. Canadian Journal of Zoology 77:1759-1767.

Hagen, J., and J. S. Baxter. 1992. Bull trout populations of the North Thompson River Basin, British Columbia: initial assessment of a biological wilderness. Report to British Columbia Ministry of Environment, Lands and Parks, Fisheries Branch, Kamloops, British Columbia.

Hansen, M.J., N.J. Horner, M.D. Liter, M.P. Peterson, and M.A. Maiolie in press. Dynamics of and increasing lake trout population in Lake Pend Oreille, Idaho, USA. North American Journal of Fisheries Management

Hayes, D. B., J. R. Bence, T. J. Kwak, and B. E. Thompson. 2007. Abundance, biomass, and production. Pages 327-374 in C. S. Guy and M. L. Brown, editors. Analysis and interpretation of freshwater fisheries data. American Fisheries Society, Bethesda.

Healey, M. C. 1978. The dynamics of exploited lake trout populations and implications for management. Journal of Wildlife Management 42:307-328.

Horner, N., and B. E. Rieman. 1984. Idaho Department of Fish and Game. Job Performance Report. F-71-R-9. Boise.

Horner, N., L.D. LaBolle, and C. Robertson. 1987. Idaho Department of Fish and Game. Job Performance Report. F-71-R-11. Boise.

Horton, B. , and D. Ronayne. 1995. Taking stock of stocking: the alpine lakes fisheries program comes under scrutiny. Idaho Wildlife 15:22.

Idaho Department of Fish and Game. 1933. Five year fish and game report, St. Joe National Forest. St. Maries.

Idaho Department of Fish and Game. 2007. Fisheries Management Plan, 2007-2012. Boise.

Johnson, D.H. 1999. The Insignificance of Statistical Significance Testing. Journal of Wildlife Management 63:763-772.

Johnson, P. 2001. Lake trout management plan. Maine Department of Inland Fisheries and Wildlife.

Knapp, R.A., P.S. Corn, and D.E. Schindler, 2000. The introduction of nonnative fish into wilderness lakes: good intentions, conflicting mandates, and unintended consequences. Ecosystems 4:275-278.

Knapp, R.A., and K.R. Matthews. 2000. Non-native fish introductions and the decline of the mountain yellow-legged frog from within protected areas. Conservation Biology 14(2): 428-438.

Lewynsky, V.A. 1986. Evaluation of special angling regulations in the Coeur d'Alene River trout fishery. Master's Thesis, University of Idaho. Moscow.

Liter, M. and N. Horner. In Press. Priest Lakes creel survey. Idaho Department of Fish and Game. Job Performance Report. Boise.

Love, R. H. 1971. Dorsal-aspect target strength of an individual fish. Journal of the Acoustic Society of America 49:816-823.

LPOBTWAG (Lake Pend Oreille Bull Trout Watershed Advisory Group). 1999. Lake Pend Oreille bull trout conservation plan. Department of Environmental Quality. Boise, Idaho.

MacLennan, D. N., and E. J. Simmonds. 1992. Fisheries Acoustics. Chapman and Hall. New York, New York.

Mallet, J.L. 1967. St. Joe River fisheries investigations. Idaho Department of Fish and Game. St. Joe Creel Census Studies. Boise.

Mauser, G.R. and V. Ellis. 1985. Enhancement of trout in large north Idaho lakes. Idaho Department of Fish and Game. Job Performance Report. Project F-73-R-6. Boise.

Mauser, G.R, 1986. Enhancement of trout in large, north Idaho lakes. Federal Aid in Fish Restoration. Job Performance Report. F-73-R-6. Idaho Department of Fish and Game. Boise.

Mauser, G.R. 1986. Enhancement of trout in large North Idaho lakes. Idaho Department of Fish and Game. Job Performance Report. F-73-R-8. Boise.

Mauser, G. R., R. W. Vogelsang, and C. L. Smith. 1988. Enhancement of trout in large north Idaho Lakes. Idaho Department of Fish and Game. Job Performance Report. F-73-R-9. Boise.

Maxell, B.A. 1999. A power analysis on the monitoring of bull trout stocks using redd counts. North American Journal of Fisheries Management. 19(3):860-866.

McPhail, J.D. and C.B. Murray. 1979. The early life history and ecology of Dolly Varden (*Salvelinus malma*) in the upper Arrow Lakes. Submitted to BC Hydro and Power Authority and Kootenay Region Fish and Wildlife.

McPhail, J.D., and P.M. Troffe. 1998. The mountain whitefish (*Prosopium williamsoni*): a potential indicator species for the Fraser System. DOE FRAP 1998-16. Prepared for Environment Canada, Environmental Conservation Branch, Aquatic and Atmospheric Sciences Division. May 1998.

Meyer, K.A. and D. J. Schill. 2007. Multistate high mountain lakes summit. Idaho Department of Fish and Game Annual Performance Report. Project F-73-R-29. Boise.

Milliken, G.A. and D.E. Johnson. 1992. Analysis of messy data, Volume I: Designed Experiments. Chapman and Hall London UK.

Mink, L.L., R.E. Williams, and A.T. Wallace. 1971. Effects of industrial and domestic effluents on the Coeur d'Alene River basin. Idaho Bureau of Mines and Geology. Pamphlet 140. Moscow.

Murphy, P.D., 2002. The effects of different species of introduced salmonids on amphibians in headwaters lakes of north-central Idaho. Masters Thesis, Idaho State University. Pocatello.

Nelson, W.C. 1988. High lake research and management in Colorado. Colorado Division of Wildlife, Special Report Number 64. Fort Collins.

Newman, R.M., and F.B. Martin. 1983. Estimation of fish production rates and associated variances. Canadian Journal of Fisheries and Aquatic Sciences 40:1729-1736.

Peterman, R.M. 1990. Statistical power can improve fisheries research and management. Canadian Journal of Fisheries and Aquatic Sciences 47:2-15.

Pearson, T.N., W. L. Hiram and G.A. Lamberti. 1992. Influence of habitat complexity on resistance to flooding and resilience of stream fish assemblies. Transactions of the American Fisheries Society 121:427-436.

Pilliod, D.S., and C.R. Peterson. 2000. Evaluating effects of fish stocking on amphibian populations in wilderness lakes. USDA Forest Service Proceedings. RMRS-P-15-VOL-5.

Pilliod, D.S., and C.R. Peterson. 2001. Local and landscape effects of introduced trout on amphibians in historically fishless watersheds. Ecosystems 4:322-333.

Pratt, K.L. 1984. Pend Oreille trout and char life history study. Idaho Department of Fish and Game. Boise.

Rabe, F.W. and C.W. Sappington. 1970. Biological productivity of the Coeur d'Alene rivers as related to water quality. Water Resources Research Institute. Technical Completion Report, Project A-024-IDA. University of Idaho. Moscow.

Rana, K.J. (1995). Cryopreservation of fish spermatozoa. Chapter 6, pp. 151-165. In: Cryopreservation and Freeze-Drying Protocols. Day, G.D. and McLellan, M.R. (Eds.)

Rankle, G.L. 1971. An appraisal of the cutthroat trout fishery of the St. Joe River. Master's Thesis, University of Idaho, Moscow.

Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish populations. Bulletin 191 of the Fisheries Research Board of Canada, Ottawa.

Rieman, B.E. and L. LaBolle. 1980. Coeur d'Alene Lake Creel Census. Idaho Department of Fish and Game. Federal Aid in Fish and Wildlife Restoration. F-73-R-2. Job Performance Report. Boise.

Rieman, B. E. and N.J. Horner. 1984. Region 1 lowland lakes investigations. Idaho Department of Fish and Game. Job Performance Report. Project F-71-R-8, Boise.

Rieman, B.E. and D. Myers. 1990. Status and analysis of salmonid fisheries. Idaho Department of Fish and Game. Job Performance Report. Federal Aid in Fish and Wildlife Restoration. F-73-R-12. Boise.

Rieman, B.E. and D. Myers. 1991. Kokanee population dynamics. Idaho Department of Fish and Game. Job Completion Report. Project F-73-R-13. Boise.

Rieman, B.E. 1992. Status and analysis of salmonids fisheries: kokanee salmon population dynamics and kokanee salmon monitoring guidelines, Idaho Department of Fish and Game. Job Performance Report. Project F-73-R-14. Boise.

Rieman, B.E., and M.A. Maiolie. 1995. Kokanee population density and resulting fisheries. North American Journal of Fisheries Management 15:229-237.

Rieman, B. E., and J. D. McIntyre. 1996. Spatial and temporal variability in bull trout redd counts. North American Journal of Fisheries Management 16:132–141.

Rieman, B.E., and D.L. Myers. 1997. Use of redd counts to detect trends in bull trout (*Salvelinus confluentus*) populations. Conservation Biology. 11(4):1015-1018.

Rothrock, G. 1995. Phase 1 Diagnostic and Feasibility Analysis – Cocolalla Lake, Bonner County Idaho 1990-1992. Idaho Department of Health and Welfare Division of Environmental Quality. Boise.

Schill, D.J., J.S. Griffith, and R.E. Gresswell. 1986. Hooking mortality of cutthroat trout in a catch-and-release segment of the Yellowstone River, Yellowstone National Park. North American Journal of Fisheries Management 6:226-232.

Schriever, E., and D. Schiff. 2002. Regional fisheries management investigations. Bull trout life history investigations in the North Fork Clearwater River basin. Idaho Department of Fish and Game. Boise.

Schriever, E., and T. Rhodes. 2002. High mountain lakes study design and protocol addressing amphibian risk assessment. Unpublished Idaho Department of Fish and Game report.

Soltero, R.A., and J.A. Hall. 1984. Water quality assessment of Spirit Lake, Idaho. Eastern Washington University, Cheney.

Simmonds, J. and D. MacLennan. 2005. Fisheries acoustics theory and practice. Second edition. Blackwell Publishing.

Sokal R. and F.J. Rohlf. 1995. Biometry: the principles and practice of statistics in biological research. 3rd edition. W.H. Freeman, New York.

Strong, C.C., and C.S. Webb. 1970. White pine: king of many waters. Mountain Press Publishing Co. Missoula.

Swanston, D.N. 1991. Natural processes. American Fisheries Society Special Publication 19:139-179.

Teuscher, D. 1999. Zooplankton Quality Index. Hatchery Trout Evaluations. Job Performance Report F-73-R-21. Idaho Department of Fish and Game. Boise.

Tyler, T., W.J. Liss, L.M. Ganio, G.L. Larson, R. Hoffman, E. Deimling, G. Lomnicky. 1998. Interaction between introduced trout and larval salamanders in high-elevation lakes. Conservation Biology. 12(1):94-105.

USFWS (U.S. Fish and Wildlife Service). 2002. U.S. Fish and Wildlife Service Bull Trout (*Salvelinus confluentus*) Draft Recovery Pan. Portland.

Von Bertalanffy, L. 1938. A quantitative theory of organic growth. Human Biology 10:181-213.

Winans, G.A., P.B. Aebersold, and R.S. Waples. 1996. Allozyme variability of Oncorhynchus nerka in the Pacific northwest, with special consideration to populations of Redfish Lake, Idaho. Transactions of the American Fisheries Society 125:645-663.

APPENDICES

Appendix A. Primary and secondary drainages, size (ha), elevation (m), and location of 138 lakes above 1000 m with a surface area of at least 0.5 ha in Idaho's Panhandle Region (updates from 2008 included).

Primary Drainage	Lake	Secondary Drainage	Area (ha)	Elevation	Longitude x Latitude (UTM)	Quadrangle	Stocked Y/N
Clark Fork	Still Lake	Lightning Creek	0.8	1347	56392 x 53435	Clark Fork	
Clark Fork	Blacktail Lake	Lightning Creek	1.5	1689	56402 x 53546	Trestle Peak	
Clark Fork	Gem Lake	Lightning Creek	2.6	1760	56450 x 53685	Mt. Pend Oreille	
Clark Fork	Porcupine Lake	Lightning Creek	4.5	1457	56040 x 53433	Clark Fork	Y
Clark Fork	Lake Darling	Lightning Creek	4.6	1607	56220 x 53614	Mt. Pend Oreille	
Clark Fork	Moose Lake	Lightning Creek	6.4	1657	56690 x 53558	Benning Mtn.	
Coeur d'Alene	no name	Beaver Creek	0.7	1720	59560 x 52626	Thompson Pass	
Coeur d'Alene	Lower Glidden L.	Canyon Creek	5.7	1709	59535 x 52632	Thompson Pass	Y
Coeur d'Alene	Upper Glidden L.	Canyon Creek	7.5	1797	59646 x 52633	Thompson Pass	
Coeur d'Alene	no name	East Fork Big Creek	0.5	1707	57418 x 52527	Polaris Peak	
Coeur d'Alene	no name	East Fork Big Creek	0.6	1597	57355 x 52535	Polaris Peak	
Coeur d'Alene	Elsie Lake	East Fork Big Creek	6.3	1545	57325 x 52538	Polaris Peak	Y
Coeur d'Alene	Lost Lake	Lake Creek	2.6	1530	57538 x 52563	Wallace	
Coeur d'Alene	Mirror Lake	Latour Creek	0.6	1756	54875 x 52236	Twin Crags	
Coeur d'Alene	Crystal Lake	Latour Creek	4.1	1622	54635 x 52470	Rochat Lake	Y
Coeur d'Alene	Revett Lake	Prichard Creek	8.4	1719	59390 x 52860	Burke	Y
Coeur d'Alene	no name	Willow Creek	1.5	1694	58859 x 52539	Mullan	
Coeur d'Alene	Loon Lake	Willow Creek	2.2	1698	59250 x 52539	Mullan	
Coeur d'Alene	Upper Stevens Lake	Willow Creek	4.8	1749	59360 x 52533	Mullan	
Coeur d'Alene	Lower Stevens Lake	Willow Creek	11.4	1688	59340 x 52935	Mullan	
Kootenai	Little Ball Lake	Ball Creek	0.6	2013	52985 x 54039	Pyramid Lake	Y
Kootenai	Ball Creek Lake	Ball Creek	2.7	2045	52995 x 54043	Pyramid Lake	Y
Kootenai	Kent Lake	Ball Creek	5.7	1720	52477 x 53969	The Wigwams	
Kootenai	Myrtle Lake	Ball Creek	8.1	1812	52782 x 54010	Pyramid Lake	Y
Kootenai	no name	Boulder Creek	0.6	1646	56187 x 53743	Clifty Mtn.	
Kootenai	Search Lake	Boundary Creek	0.9	1707	51348 x 54184	Grass Mtn.	
Kootenai	Joe Lake	Boundary Creek	1.5	1703	51654 x 54148	Grass Mtn.	
Kootenai	Marsh Lake	Boundary Creek	1.8	1755	51560 x 54208	Grass Mtn.	
Kootenai	Hidden Lake	Boundary Creek	18.0	1659	51800 x 54145	Grass Mtn.	Y
Kootenai	Canyon Lake	Canyon Creek	1.0	1790	52790 x 54165	Shorty Peak	
Kootenai	Roman Nose #1	Caribou Creek	6.6	1888	53070 x 53866	Roman Nose	
Kootenai	Roman Nose #2	Caribou Creek	3.3	1805	53020 x 53874	Roman Nose	
Kootenai	Roman Nose #3	Caribou Creek	4.8	1796	53145 x 53865	Roman Nose	Y
Kootenai	Debt Lake	Debt Creek	0.5	1746	56200 x 53872	Moyie Springs	Y
Kootenai	Parker Lake	Long Canyon Creek	1.9	1926	52957 x 54121	Pyramid Lake	Y
Kootenai	no name	Moyie R	1.1	1756	56935 x 54030	Line Point	
Kootenai	Solomon Lake	Moyie R	4.6	1024	56525 x 54052	Line Point	Y
Kootenai	Copper Lake	Moyie River	0.5	1804	56561 x 54269	Canuck Peak	Y
Kootenai	Queen Lake	Moyie River	1.0	1711	55835 x 54148	Eastport	Y
Kootenai	Spruce Lake	Moyie River	2.6	1660	56504 x 54185	Canuck Peak	Y
Kootenai	no name	Myrtle Creek	0.5	1097	54118 x 53874	Moravia	
Kootenai	no name	Myrtle Creek	0.6	1917	52534 x 53939	The Wigwams	
Kootenai	no name	Myrtle Creek	0.9	1712	52875 x 53984	Roman Nose	
Kootenai	no name	Myrtle Creek	1.1	1113	54389 x 53878	Moravia	

Primary Drainage	Lake	Secondary Drainage	Area (ha)	Elevation	Longitude x Latitude (UTM)	Quadrangle	Stocked Y/N
Kootenai	no name	Myrtle Creek	1.2	1113	54382 x 53878	Moravia	
Kootenai	Cooks Lake	Myrtle Creek	2.7	1768	53070 x 52939	Roman Nose	
Kootenai	Brooks Lake	Myrtle Creek	3.2	1806	52850 x 53930	Roman Nose	
Kootenai	Callahan Lake	Callahan Creek	3.2	1732	56550 x 53642	Smith Mtn.	Y
Kootenai	Long Mtn. Lake	Parker Creek	0.8	2044	52835 x 54087	Pyramid Lake	Y
Kootenai	Big Fisher Lake	Parker Creek	3.7	2052	53120 x 54095	Pyramid Lake	Y
Kootenai	Smith Lake	Smith Creek	1.9	1936	52305 x 54097	Smith Peak	Y
Kootenai	Cutoff Lake	Smith Creek	2.0	1886	52360 x 54110	Smith Peak	Y
Kootenai	West Fork Lake	Smith Creek	4.5	1759	51855 x 54091	Smith Peak	Y
Kootenai	no name	Snow Creek	0.5	1780	52996 x 53891	Roman Nose	
Kootenai	Snow Lake	Snow Creek	3.4	1805	52915 x 53877	Roman Nose	Y
Kootenai	Bottleneck Lake	Snow Creek	4.4	1714	52962 x 53893	Roman Nose	
Kootenai	Trout Lake	Trout Creek	2.7	1844	53075 x 54074	Pyramid Lake	Y
Kootenai	Pyramid Lake	Trout Creek	3.2	1844	52805 x 54051	Pyramid Lake	Y
Kootenai	Lake Estelle	Callahan Creek	1.7	1757	56568 x 53594	Smith Mtn.	
LNFCR	Lost Lake	Lost Lake Creek	10.4	1687	57980 x 52136	Widow Mtn	
LNFCR	No-See-Um Lake	Butte Creek	1.9	1682	59200 x 52080	Monumental Buttes	Y
LNFCR	Dismal Lake	Butte Creek	2.6	1634	60340 x 52189	Montana Peak	Y
LNFCR	Steamboat Lake	Butte Creek	2.9	1804	59110 x 52083	Monumental Buttes	Y
LNFCR	no name	Butte Creek	1.7	1219	58740 x 52160	Monumental Buttes	
LNFCR	no name	Butte Creek	0.7	1256	58709 x 52157	Monumental Buttes	
LNFCR	no name	Butte Creek	0.4	1280	58790 x 52165	Monumental Buttes	
LNFCR	Devil's Club Lake	Devil's Club Creek	1.2	1573	60360 x 52011	Buzzard Roost	Y
LNFCR	Little Lost Lake	Little Lost L. Creek	1.3	1757	58060 x 52128	Widow Mtn.	
LNFCR	no name	LNFCR	0.7	1853	57793 x 52151	Widow Mtn.	
LNFCR	Fish Lake	LNFCR	2.2	1654	57830 x 52167	Widow Mtn.	
LNFCR	Northbound Lake	Sawtooth Creek	4.7	1657	60825 x 51992	Mallard Peak	Y
LNFCR	Black Lake	Sawtooth Creek	1.3	1951	61027 x 51925	Mallard Peak	
LNFCR	Gnat Lake	Sawtooth Creek	1.5	1782	60600 x 52018	Mallard Peak	
LNFCR	Mud Lake	Sawtooth Creek	1.9	1792	60699 x 52011	Mallard Peak	Y
LNFCR	Hero Lake	Sawtooth Creek	2.0	1585	60610 x 52023	Mallard Peak	Y
LNFCR	Crag Lake	Sawtooth Creek	3.0	1792	60785 x 52003	Mallard Peak	
LNFCR	Larkins Lake	Sawtooth Creek	3.3	1707	60540 x 52004	Mallard Peak	Y
LNFCR	Fawn Lake	Sawtooth Creek	4.9	1823	61230 x 52014	Mallard Peak	Y
LNFCR	Skylard Lake	Sawtooth Creek	5.4	1463	61148 x 52005	Mallard Peak	Y
LNFCR	Heart Lake	Sawtooth Creek	13.4	1859	60735 x 51994	Mallard Peak	Y
LNFCR	Big Talk Lake	Foehl Creek	2.1	1654	59050 x 52044	Little Goat Mtn.	Y
Pack River	Caribou Lake	Caribou Creek	2.8	1583	52435 x 53643	Mt. Casey	Y
Pack River	Keokee Lake	Caribou Creek	2.3	1694	52550 x 53630	Mt. Casey	
Pack River	no name	McCormick Creek	0.6	1802	52260 x 53832	Mt. Roothan	
Pack River	McCormick Lake	McCormick Creek	1.1	1851	52220 x 53781	Mt. Roothan	Y
Pack River	Fault Lake	McCormick Creek	2.3	1823	52255 x 53785	Mt. Roothan	Y
Pack River	no name	McCormick Creek	1.5	2036	52217 x 53809	Mt. Roothan	
Pend Oreille	Beehive Lake #2	Beehive Creek	2.5	1968	52550 x 53891	The Wigwams	Y
Pend Oreille	Kilroy Lake #1	Kilroy Creek	0.7	1158	54640 x 53297	Packsaddle Mtn.	
Pend Oreille	Kilroy Lake #2	Kilroy Creek	1.0	1158	54618 x 53297	Packsaddle Mtn.	
Pend Oreille	Beehive Lake #1	Pack River	2.3	1911	52560 x53897	The Wigwams	
Pend Oreille	no name	Pack River	2.4	1122	55234 x 53653	Wylie Knob	

Primary Drainage	Lake	Secondary Drainage	Area (ha)	Elevation	Longitude x Latitude (UTM)	Quadrangle	Stocked Y/N
Pend Oreille	Harrison Lake	Pack River	11.7	1884	52560 x 53917	The Wigwams	Y
Pend Oreille	Little Harrison	Pack River	2.6	1866	52250 x 53907	The Wigwams	Y
Priest River	no name	Caribou Creek	0.6	1640	51652 x 54116	Caribou Creek	
Priest River	Caribou Lakes #3	Caribou Creek	0.7	1711	51743 x 54033	Caribou Creek	
Priest River	Caribou Lakes #1	Caribou Creek	0.7	1779	51710 x 54102	Caribou Creek	
Priest River	Mollies Lake	Caribou Creek	0.8	1685	51240 x 54107	Caribou Creek	Y
Priest River	Lookout Lake	Caribou Creek	1.1	1696	51679 x 54027	Caribou Creek	
Priest River	Caribou Lakes #2	Caribou Creek	3.9	1690	51746 x 54097	Caribou Creek	
Priest River	Hunt Lake	Hunt Creek	5.6	1772	52106 x 53805	Mt. Roothan	Y
Priest River	Two Mouth Lake #2	Two Mouth Creek	1.5	1777	52552 x 53949	The Wigwams	Y
Priest River	Two Mouth Lake #3	Two Mouth Creek	1.6	1927	52500 x 53933	The Wigwams	
Priest River	Standard Lake #2	Two Mouth Creek	2.4	1555	52195 x 53920	The Wigwams	
Priest River	Two Mouth Lake	Two Mouth Creek	3.2	1781	52695 x 53947	The Wigwams	Y
Priest River	Standard Lake #1	Two Mouth Creek	5.3	1621	52101 x 53921	The Wigwams	Y
St. Joe	no name	Bacon Creek	0.8	1725	63082 x 52023	Bacon Peak	
St. Joe	no name	Bacon Creek	1.1	1926	63298 x 52023	Bacon Peak	
St. Joe	no name	Canyon Creek	0.5	1719	60434 x 52116	Bathtub Mtn.	
St. Joe	Halo Lake	Dump Creek	4.0	1865	63270 x 52039	Bacon Peak	Y
St. Joe	Forage Lake	Forage Creek	2.9	1756	63160 x 52041	Bacon Peak	Y
St. Joe	no name	Gold Creek	0.7	1682	63085 x 52177	Red Ives Peak	
St. Joe	Crater Lake	Marble Creek	1.5	1756	57676 x 52094	Widow Mtn.	Y
St. Joe	Theiault Lake	Marble Creek	1.8	1747	57346 x 52226	Marble Mtn.	
St. Joe	no name	Mica Creek	0.5	1017	56414 x 52199	Huckleberry Mtn.	
St. Joe	no name	North Fork St. Joe	0.6	1731	59978 x 52404	Shefoot Mtn.	
St. Joe	no name	Simmons Creek	1.3	1960	63716 x 52192	Sherlock Peak	
St. Joe	St. Joe Lake	St. Joe River	7.8	1654	64500 x 52087	Illinois Peak	
St. Joe	Crow Lake	Fishhook Creek	2.1	1768	58142 x 52181	Widow Mtn.	
St. Joe	no name	Gold Creek	1.1	1902	62945 x 52170	Red Ives Peak	
St. Joe	Swimming Bear L.	Gold Creek	1.2	1902	62828 x 52184	Red Ives Peak	
St. Joe	no name	Marble Creek	0.5	1824	57810 x 52107	Widow Mtn.	

Additional Mountain lakes added to the list in 2008 (although Sand is below 1,000 m it is considered a mountain lake)

Primary Drainage	Lake	Secondary Drainage	Area (ha)	Elevation	Easting	Northing	Stocked (Y/N)
St. Joe	Bacon Lake	Bacon Creek	2.08	1,790	631629	5203027	Y
Kootenai	Beaver Lake	Twenty Mile Creek	1.99	1,171	546201	5374295	
Priest	Continental Lake	Cedar Creek	0.45	1,820	506680	5418748	
Kootenai	Fisher Peak Lake	Parker Creek	0.84	2,050	533865	5413116	
Priest	Goblin Lake	Two Mouth Creek	2.42	1,555	520766	5392141	
Coeur d' Alene	Gold Lake	S.F. Coeur d' Alene River	1.48	1,721	588354	5454124	
St. Joe	Frog Lake	Sherlock Creek	1.32	1,930	639613	5216935	
Priest	Knob Lake	Two Mouth Creek	1.67	1,866	522363	5390971	
Coeur d' Alene	Lone Lake	Willow Creek	2.19	1,697	592406	5254106	
Kootenai	Saddle Lake	Boundary Creek	0.43	1,930	517190	5422111	
Pack River	Sand Lake	Sand Creek	1.98	978	545253	5372122	Y
St. Joe	Simmons Lake	Simmons Creek	1.08	1,951	629476	5217212	
Kootenai	West Fork Smith Creek Pond #1	West Fork Smith Creek	0.45	1,510	518045	5412886	
Kootenai	West Fork Smith Creek Pond #2	West Fork Smith Creek	0.30	1,513	518083	5412978	
Kootenai	West Fork Smith Creek Pond #3	West Fork Smith Creek	0.46	1,472	518388	5412971	
Kootenai	West Fork Smith Lake	West Fork Smith Creek	2.18	1,769	518475	5409651	

Appendix B. Physical parameters and fisheries data collected from mountain lakes sampled in 2008 in the Panhandle Region, Idaho.

				AGR			BKT			BLT			BRN			RBT			WCT		
Lake Name	Max Depth (m)	Stocked	Surface Area (hs)	Min TL (mm)	Max TL (mm)	K	Min TL (mm)	Max TL (mm)	K	Min TL (mm)	Max TL (mm)	K	Min TL (mm)	Max TL (mm)	K	Min TL (mm)	Max TL (mm)	K	Min TL (mm)	Max TL (mm)	K
Beaver Lake	3.05	N	1.99				203	310	1.02												
Beehive Lake	4.27	Y	2.41																183	295	0.81
Bottleneck Lake	8.72	N	4.38				160	221	0.93												
Carbibou Lake (Pack)	9.14	Y	2.30																295	356	1.05
Caribou Lake (Priest)	5.97	N	2.30				161	282	1.03												
Copper Lake	5.91	Y	0.54																239	242	0.71
Crater Lake	3.29	Y	1.53	162	675	0.74															
Crow Lake	6.71	N	0.69																		
Darling Lake	6.60	N	4.63				125	265	0.93												
Dennick Lake	8.53	Y	2.69										235	434	1.18				242	255	0.95
Dismal Lake	21.64	Y	2.56													229	336	0.90			
Elsie Lake	14.63	N	6.21				163	262	0.85							215	237	0.89			
Fish Lake	3.41	N	2.09																170	285	0.92
Gem Lake	NA	N	2.64				150	286	0.95												
Gnat Lake	6.40	N	1.45																		
Harrison Lake	19.81	Y	11.54																143	295	0.88
Hero Lake	10.10	Y	2.04																155	355	0.92
Hidden Lake	21.95	Y	17.82													187	260	1.03	271	394	0.90
Hunt Lake	7.92	Y	5.63																200	302	0.96
Joe Lake	2.41	N	1.54																		
Lake Estelle	7.47	N	1.68				195	635	1.04												
Larkins Lake	4.60	Y	3.20																155	344	1.13
Little Ball Lake	3.50	Y	0.57																184	251	0.87
Little Lost Lake	3.75	N	1.34																		
Lookout Lake	1.70	N	1.03																		
Lost Lake	22.25	N	2.59																242	355	1.18
Lower Glidden Lake	4.48	Y	5.60				144	210	1.00							216	282	0.87			
Lower Stevens Lake	28.65	N	11.22				140	257	0.94												
Moose Lake	2.99	N	6.29				180	243	0.98												
No-see-um Lake	10.85	Y	1.97																		
Pyramid Lake	4.45	Y	3.05													260	321	1.11			
Queen Lake	5.49	Y	0.98																		
Revett Lake	12.19	N	8.21				158	250	0.83												
Roman Nose Lake 1	18.20	N	6.75				142	280	0.97	200	700	1.01									
Roman Nose Lake 2	7.01	N	3.50				158	225	0.85												
Roman Nose Lake 3	5.06	Y	4.32																247	280	1.02
Sand Lake	4.72	Y	1.98																220	438	1.00
Snow Lake	5.91	Y	3.35																139	285	1.12
Spruce Lake	10.06	Y	2.59																248	395	1.14
St Joe Lake	7.80	N	7.81																126	321	1.06

AGR: (Arctic grayling); BKT: (brook trout); BLT: (bull trout); BRN: (brown trout); RBT: (rainbow trout); WCT: (westslope cutthroat trout)

Appendix B. Continued.

				AGR			BKT			BLT			BRN			RBT			WCT		
Lake Name	Max Depth	Stocked	Surface Area	Min TL (mm)	Max TL (mm)	K	Min TL (mm)	Max TL (mm)	K	Min TL (mm)	Max TL (mm)	K	Min TL (mm)	Max TL (mm)	K	Min TL (mm)	Max TL (mm)	K	Min TL (mm)	Max TL (mm)	K
Standard Lake	4.27	Y	5.37																220	250	0.93
Steamboat Lake	10.15	Y	2.95	123	134	0.70															
Theiralt Lake	7.8	N	1.76																		
Two mouth 1	3.66	N	1.64																		
Two Mouth Lake 3	6.71	Y	1.39																193	315	0.91
Upper Ball Lake	14.51	Y	2.68																186	265	0.94
Upper Glidden Lake	28.96	N	7.62				154	258	0.87	340	545	0.99									
Upper Stevens Lake	26	N	4.87				125	257	1.09												
West Fork Lake	7.62	Y	4.23																170	295	0.98
West Fork Smith Creek Pond 1	1.19	N	0.45				126	242	1.02												
West Fork Smith Lake	1.22	N	0.22																		

AGR: (Arctic grayling); BKT: (brook trout); BLT: (bull trout); BRN: (brown trout); RBT: (rainbow trout); WCT: (westslope cutthroat trout).

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